Western Boundary Time Series

April 16 – May 5, 2009
Preliminary Cruise Report (RB0901)

Participants:
Christopher Meinen – NOAA/AOML – Chief Scientist
Andrew Stefanick – NOAA/AOML
Carlos Fonseca – U. Miami/CIMAS
Kyle Seaton – U. Miami/CIMAS
Pedro Pena – NOAA/AOML
Benjamin Shaw – U. Miami/RSMAS
Wendy Saintval – U. Miami/RSMAS
Darren Rayner – NOCS, United Kingdom
Harry Bryden – NOCS, United Kingdom
Emma Heslop – NOCS, United Kingdom
Paul Wright – NOCS, United Kingdom
Rob McLachlan – NOCS, United Kingdom
Christian Crowe – NOCS, United Kingdom
Colin Hutton – NOCS, United Kingdom
David Childs – NOCS, United Kingdom
Stephen Whittle – NOCS, United Kingdom

Departure Port: Charleston, SC
Arrival Port: Charleston, SC
Vessel: NOAA Ship Ronald H. Brown

Atlantic Oceanographic & Meteorological Laboratory
National Oceanic & Atmospheric Administration

Introduction

The NOAA-funded Western Boundary Time Series (WBTS) experiment is designed to monitor the shallow and deep components of the Atlantic Meridional Overturning Circulation (MOC) near the western boundary of the basin at about 26.5°N. The program began in 1982 as a joint venture between NOAA's two blue-water laboratories, the Atlantic Oceanographic and Meteorological Laboratory in Miami, Florida and the Pacific Marine Environmental Laboratory in Seattle, Washington, with additional involvement from the Rosenstiel School for Marine and Atmospheric Studies at the University of Miami. Initially known as the Subtropical Atlantic Climate Studies program, the program had a focus on the temperature structure and volume transport of the Florida Current in the Straits of Florida at 27°N. In 1984 the program expanded offshore of the Bahamas, measuring changes in temperature, salinity, and transport in the Antilles Current and Deep Western Boundary Current along 26.5°N east of Abaco Island. By the year 2000 the WBTS program had shifted under the sole management of the Atlantic Oceanographic and Meteorological Laboratory (AOML), where it continues to measure changes in the Florida Current, Antilles Current and Deep Western Boundary Current. In 2004 the AOML WBTS program became the cornerstone of an international collaborative program with partners from the University of Miami and the United Kingdom's National Oceanography Centre, Southampton, in an ambitious plan to build upon the observations made along the western boundary through monitoring the net transport across the entire Atlantic basin at 26.5°N from the Florida coast to the coast of Africa for a ten year period. The National Science Foundation component of this international partnership is the 'Meridional Overturning Circulation Heat-flux Array', while the British component is funded through the United Kingdom's Natural Environment Research Council RAPID-MOC program.

Numerous climate-modeling studies have demonstrated that global climate change may be heralded by changes in the transport of the MOC, which provides the motivation for a long-term observation program. Over the 25+ intervening years since NOAA began the first sustained program, the measurement systems and techniques have changed but the backbone of the program has always involved a strong hydrographic component. As part of this project in the modern era, annual or semi-annual cruises are completed on a line east of Abaco Island in the Bahamas along 26.5°N, on a short section across the Northwest Providence Channel, and on two short sections across the Straits of Florida (at 26°N and 27°N). Conductivity-temperature-depth (CTD) profiles are obtained at numerous sites along these lines using an instrument package lowered from the ship down to about twenty meters above the ocean bottom. One or two Lowered Acoustic Doppler Current Profilers (LADCPs) are included on this package, and the LADCPs provide vector profiles of absolute velocity as a function of depth. By combining these data sets, along with the measurements of the ship's hull-mounted Acoustic Doppler Current Profiler (SADCP), it is possible to monitor changes in the mass, heat, and salt transports carried by the Deep Western Boundary Current (DWBC) as it flows southward along the continental slope, as well as by the Florida Current and the Antilles Current as they carry warm surface waters northward. In addition to the snapshot estimates obtained by the hydrographic sections, time series observations of the DWBC and the Antilles Current volume transports have been obtained as part of the WBTS program in a quasi-real time manner since 2004 using moored inverted echo sounders, deep pressure gauges, and a single deep current meter. Data from these moored instruments are downloaded via acoustic telemetry during the cruises. Variability of the Florida Current volume transport has been monitored since 1982 with a submarine telephone cable as another part of the Western Boundary Time Series project.

This report has been prepared using the data obtained on the April-May 2009 Western Boundary Time Series cruise (Ronald H. Brown cruise designation RB-09-01; WBTS program designation AB0904). The April-May 2009 cruise also included the turn-around of the British western boundary moorings deployed as part of the international RAPID-MOC/MOCHA program. The data presented herein are preliminary; final calibration and processing of the data obtained on this cruise will be completed back in the labs.

Our sincere thanks go out to the officers and crew of the NOAA Ship Ronald H. Brown for their gracious help with our work during this cruise. Without their help none of this work would have been possible. Our thanks also go out to Drs. Julia Hummon and Eric Firing at the University of Hawaii for their work in maintaining the shipboard acoustic Doppler current profiler data acquisition system and processing software on the ship. The chief scientist would also like to extend his sincere appreciation to all of the participants of the cruise, each of whom contributed greatly to the work we completed.

The bulk of this report consists of a discussion of the operations that were completed during the cruise and a presentation of the preliminary data collected during the cruise. Detailed scientific analysis of the data will occur at a later date.

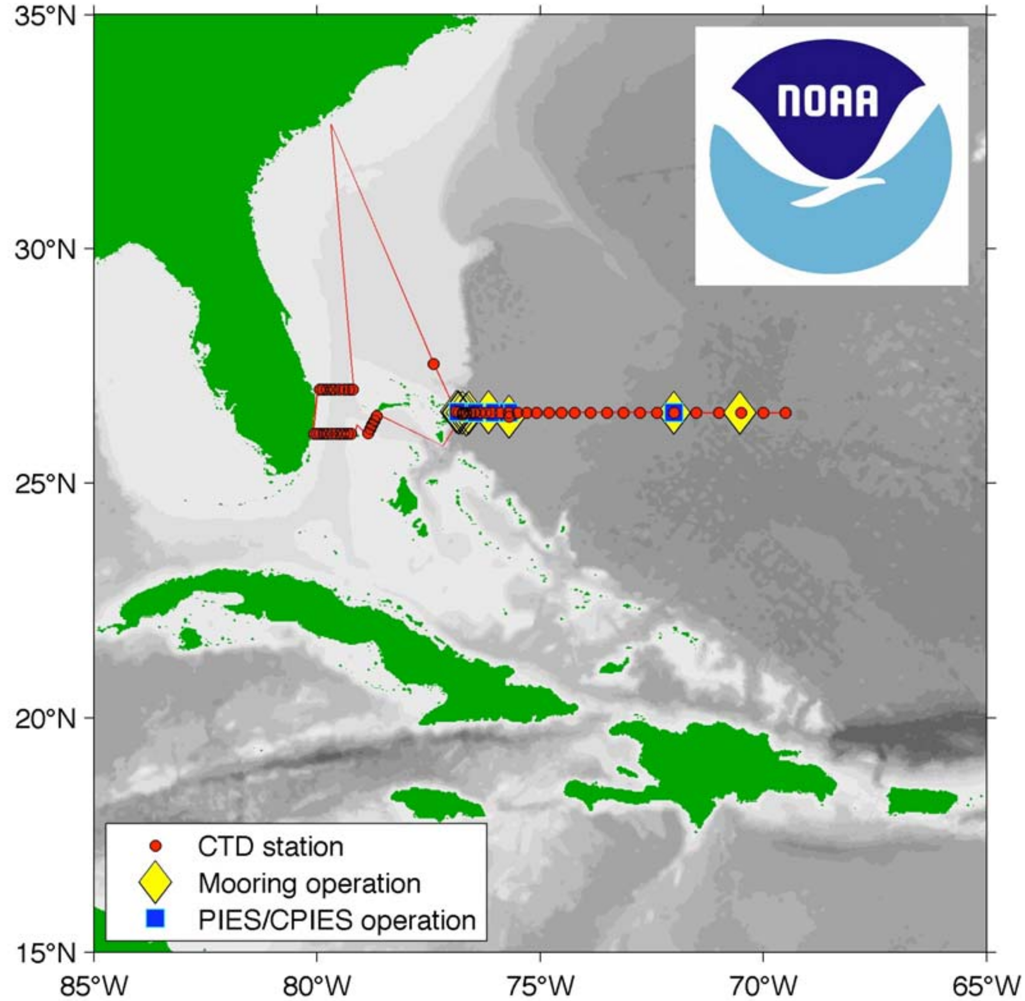


Figure 1: Map of the April-May 2009 WBTS cruise.

<u>Order of operations:</u>

The cruise was originally scheduled to depart from Charleston on April 15 and return to Charleston on May 5, however problems with the engines (specifically with a field exciter in a propulsion unit) resulted in Commanding Officer Capt. Gerd Glang pushing back the schedule for the cruise by one day. The cruise departed from Charleston on April 16 at 14:30 (local) heading towards the east side of Abaco Island, Bahamas. Initially the plan was to do a test cast en route and then clear Bahamian Customs and Immigration at Marsh Harbor in the morning on Saturday, April 18. The test cast was done in the evening on April 17 as planned however in the morning on April 18 the waves were deemed too large for a safe deployment of the small boat for clearing in Marsh Harbor. The Customs and Immigration visit was postponed until later in the cruise. Subsequent to this decision the Brown immediately headed to the site of the WB-ADCP mooring, where the old mooring was recovered and the new mooring was deployed. Then the ship transited to the site of the first CTD station on the "Abaco" line and the section commenced.

During the Abaco section, telemetry data was obtained from the PIES at sites A, C, and E as well as from the CPIES at site D. Telemetry was attempted with the PIES at site B, however the instrument failed to respond. Also during the completion of the Abaco section, several casts were used for the calibration of Microcat sensor packages for use on the UK moorings either just recovered or to be deployed later in the cruise, and several mooring releases were also tested on the later casts in this line. The Abaco CTD section (28 stations) was completed on Friday, April 24.

Mooring operations by the UK group commenced at first light on Saturday, April 25. Details of the mooring operations are presented later. During the mooring operations, additional attempts to telemeter, and then to release and recover the PIES at site B were made however these efforts failed. As a result a 'backup' IES was deployed at the B site. A second telemetry download at the PIES at site A was successfully completed during the mooring operations because the first download had been rather noisy. Also during the mooring operations a bottom moored pressure sensor owned by the University of Miami was scheduled to be recovered at the request of Dr. Bill Johns; the attempt at recovery failed when the mooring abruptly sank during hook-up, probably due to the vessel prop destroying several of the mooring flotation spheres. The moored sensor and acoustic releases are now likely irretrievably lost.

After the mooring operations were completed on Friday, May 1 the ship transited to the Northwest Providence Channel. Bahamian Customs and Immigration were cleared at Port Lucaya, Grand Bahama Island. Immediately after the customs clearance procedures were completed, the short (5 station) CTD section across the Northwest Providence Channel was initiated, followed by sections across the Florida Straits at 26°N and 27°N (11 and 9 stations, respectively). After the final CTD station along 27°N, the ship collected two additional smooth shipboard ADCP sections along the 27°N section for aiding in tidal and resolution analyses. The ship returned to Charleston on May 5, one day earlier than required, at the request of the chief scientist. Note that during the cruise six surface drifters were deployed as part of the NOAA Surface Drifter program.

Types of data collected on this cruise:

1. Data from four pressure-equipped Inverted Echo Sounders (PIES) were collected via acoustic telemetry (one of the moored instruments also contains a single-depth current meter; a CPIES).

2. Conductivity-Temperature-Depth (CTD) data were collected at 61 stations; one test cast, seven calibration/release test casts, and the four sections. On 60 stations water samples were taken at up to 23 depths to find salinity (60 stations) and oxygen (53 stations) levels.

3. Lowered Acoustic Doppler Current Profiler (LADCP) data was successfully collected at 53 of the 61 CTD stations. This data was collected using an upward looking 300 kHz Workhorse LADCP and a downward looking 150 kHz Broadband LADCP during stations 0 through 28, and using a dual 300 kHz Workhorse LADCP setup during stations 36 through 60.

4. Shipboard data was collected throughout the cruise using a 75 kHz "Ocean Surveyor" hull-mounted Acoustic Doppler Current Profiler (SADCP). A preliminary version of this data was processed using the UHDAS software installed by Dr. Julia Hummon of the University of Hawaii, however complete reprocessing is required after the cruise due to two software problems that were experienced during the cruise.

5. Six surface velocity drifters additionally equipped with sea-surface temperature sensors were deployed as part of the NOAA contribution to the Global Surface Drifter Program. The data from these drifters is not sent to the ship, but is instead sent via satellite to land-based labs where it is processed and then placed on the Global Telecommunication System.

6. Moored time series from Microcats and current meters on six moorings were collected by our UK colleagues, along with data from two bottom pressure sensors from the UK team.

Table 1 – List of PIES/CPIES moorings types and locations

Mooring name	Mooring Type	Longitude	Latitude	Operation
A	PIES	76º 50.4' W	26º 30.7' N	Telemetry
B	PIES	76º 28.3' W	26º 29.6' N	Deployment
C	PIES	76º 05.7' W	26º 30.0' N	Telemetry
D	CPIES	75º 42.2' W	26º 30.0' N	Telemetry
E	PIES	72º 00.3' W	26º 29.9' N	Telemetry

Table 2 – Locations for CTD/LADCP stations:

Cast #	Latitude (deg min)	Longitude (deg min)	Depth (m)	Start time (GMT)	End time (GMT)
00	27 32.75 N	77 23.28 W	1255	18-Apr 03:54	18-Apr 05:16
01	26 31.49 N	76 53.51 W	330	18-Apr 15:03	18-Apr 16:06
02	26 30.98 N	76 49.87 W	1125	18-Apr 17:12	18-Apr 18:36
03	26 29.93 N	76 44.60 W	3840	18-Apr 20:46	19-Apr 00:07
04	26 30.01 N	76 39.33 W	4546	19-Apr 01:22	19-Apr 05:14
05	26 29.74 N	76 33.93 W	4796	19-Apr 06:25	19-Apr 10:18
06	26 29.82 N	76 28.48 W	4800	19-Apr 12:07	19-Apr 15:57
07	26 29.53 N	76 20.83 W	4820	19-Apr 17:23	19-Apr 21:10
08	26 29.77 N	76 13.10 W	4778	19-Apr 22:53	20-Apr 02:46
09	26 30.00 N	76 05.22 W	4758	20-Apr 04:04	20-Apr 07:53
10	26 29.96 N	75 53.83 W	4708	20-Apr 09:07	20-Apr 12:54
11	26 29.97 N	75 42.21 W	4660	20-Apr 14:22	20-Apr 18:34
12	26 29.87 N	75 29.98 W	4653	20-Apr 19:54	21-Apr 00:07
13	26 30.00 N	75 18.00 W	4610	21-Apr 01:50	21-Apr 05:20
14	26 30.00 N	75 05.06 W	4590	21-Apr 06:36	21-Apr 10:13
15	26 30.02 N	74 48.01 W	4509	21-Apr 11:55	21-Apr 16:02
16	26 30.01 N	74 31.05 W	4480	21-Apr 17:39	21-Apr 21:44
17	26 30.03 N	74 13.97 W	4527	21-Apr 23:15	22-Apr 03:19
18	26 29.98 N	73 52.01 W	4717	22-Apr 05:17	22-Apr 08:55
19	26 30.03 N	73 29.91 W	4935	22-Apr 10:50	22-Apr 15:24
20	26 30.07 N	73 07.90 W	5023	22-Apr 17:14	22-Apr 21:37
21	26 29.89 N	72 46.04 W	5100	22-Apr 23:25	23-Apr 03:22
22	26 30.00 N	72 23.02 W	5149	23-Apr 05:21	23-Apr 09:11
23	26 30.00 N	72 00.00 W	5237	23-Apr 11:15	23-Apr 15:56
24	26 30.03 N	71 30.15 W	5372	23-Apr 18:40	23-Apr 23:06
25	26 29.97 N	71 00.02 W	5441	24-Apr 01:43	24-Apr 06:25
26	26 30.06 N	70 30.08 W	5442	24-Apr 09:00	24-Apr 13:14
27	26 30.04 N	70 00.13 W	5441	24-Apr 15:57	24-Apr 20:23
28	26 30.02 N	69 30.13 W	5281	24-Apr 22:59	24-Apr 03:16

Table 2 continued:

Cast #	Latitude (deg min)			Longitude (deg min)			Depth (m)	Start time (GMT)	End time (GMT)
29	26	22.49	N	75	42.33	W	4673	27-Apr 01:52	27-Apr 05:14
30	26	22.49	N	75	42.33	W	4673	27-Apr 05:39	27-Apr 08:36
31	26	29.57	N	76	28.35	W	4800	28-Apr 06:27	28-Apr 10:16
32	26	27.10	N	76	37.82	W	4721	29-Apr 00:25	29-Apr 03:31
33	26	28.00	N	76	43.63	W	3964	30-Apr 05:25	30-Apr 08:45
34	26	27.66	N	76	42.65	W	4176	30-Apr 21:45	01-May 01:20
35	26	21.95	N	76	44.75	W	4483	01-May 02:20	01-May 05:45
36	26	26.01	N	78	40.02	W	750	01-May 21:34	01-May 22:33
37	26	20.77	N	78	42.67	W	706	01-May 23:38	02-May 00:26
38	26	15.02	N	78	46.01	W	515	02-May 01:43	02-May 02:23
39	26	09.94	N	78	48.02	W	451	02-May 03:08	02-May 03:54
40	26	04.04	N	78	50.96	W	302	02-May 05:14	02-May 05:42
41	26	03.46	N	79	13.61	W	320	02-May 08:48	02-May 09:17
42	26	03.04	N	79	18.76	W	485	02-May 09:58	02-May 10:40
43	26	02.14	N	79	24.36	W	586	02-May 11:20	02-May 12:09
44	26	02.07	N	79	28.86	W	675	02-May 12:48	02-May 13:45
45	26	02.41	N	79	34.27	W	764	02-May 15:04	02-May 16:10
46	26	02.13	N	79	39.71	W	712	02-May 17:00	02-May 17:57
47	26	02.27	N	79	45.96	W	640	02-May 18:45	02-May 19:44
48	26	02.27	N	79	50.95	W	328	02-May 20:25	02-May 20:58
49	26	02.32	N	79	55.86	W	257	02-May 21:38	02-May 22:06
50	26	02.17	N	79	55.83	W	302	02-May 22:36	02-May 23:03
51	26	02.45	N	80	03.53	W	171	02-May 23:54	03-May 00:18
52	26	59.21	N	79	56.04	W	143	03-May 06:28	03-May 06:54
53	26	59.49	N	79	52.06	W	260	03-May 07:34	03-May 08:08
54	26	59.04	N	79	47.15	W	376	03-May 08:49	03-May 09:24
55	26	59.05	N	79	41.13	W	532	03-May 10:04	03-May 10:51
56	26	59.50	N	79	37.14	W	630	03-May 11:20	03-May 12:24
57	26	58.55	N	79	30.12	W	752	03-May 13:27	03-May 14:28
58	26	58.29	N	79	22.97	W	667	03-May 15:16	03-May 16:09
59	26	59.20	N	79	17.10	W	607	03-May 16:51	03-May 17:39
60	26	59.55	N	79	12.02	W	480	03-May 18:13	03-May 18:54

Table 3 – Locations of surface drifter deployments

Drifter ID#	Deployment Date (mm/dd/yyyy)	Deployment time (GMT)	Deployment Latitude (deg min)	Deployment Longitude (deg min)
88646	04/21/2009	21:52	26 30.006 N	74 30.592 W
88627	04/22/2009	04:35	26 29.994 N	73 59.852 W
88624	04/22/2009	15:33	26 30.016 N	73 29.346 W
88642	04/22/2009	22:18	26 29.995 N	73 00.045 W
88638	05/03/2009	14:37	27 00.602 N	79 29.598 W
88628	05/03/2009	16:18	26 59.830 N	79 22.689 W

Preliminary time series of data from PIES/CPIES

This section shows the preliminary, unprocessed, time series of data from the last six months, collected from the moored PIES and CPIES via acoustic telemetry. Data records are downloaded in reverse temporal order beginning two days before download. All records are subject to time gaps at this level of processing. A simple standard deviation despiking has been employed in these figures. Final processing will take place over several months at the lab after the cruise.

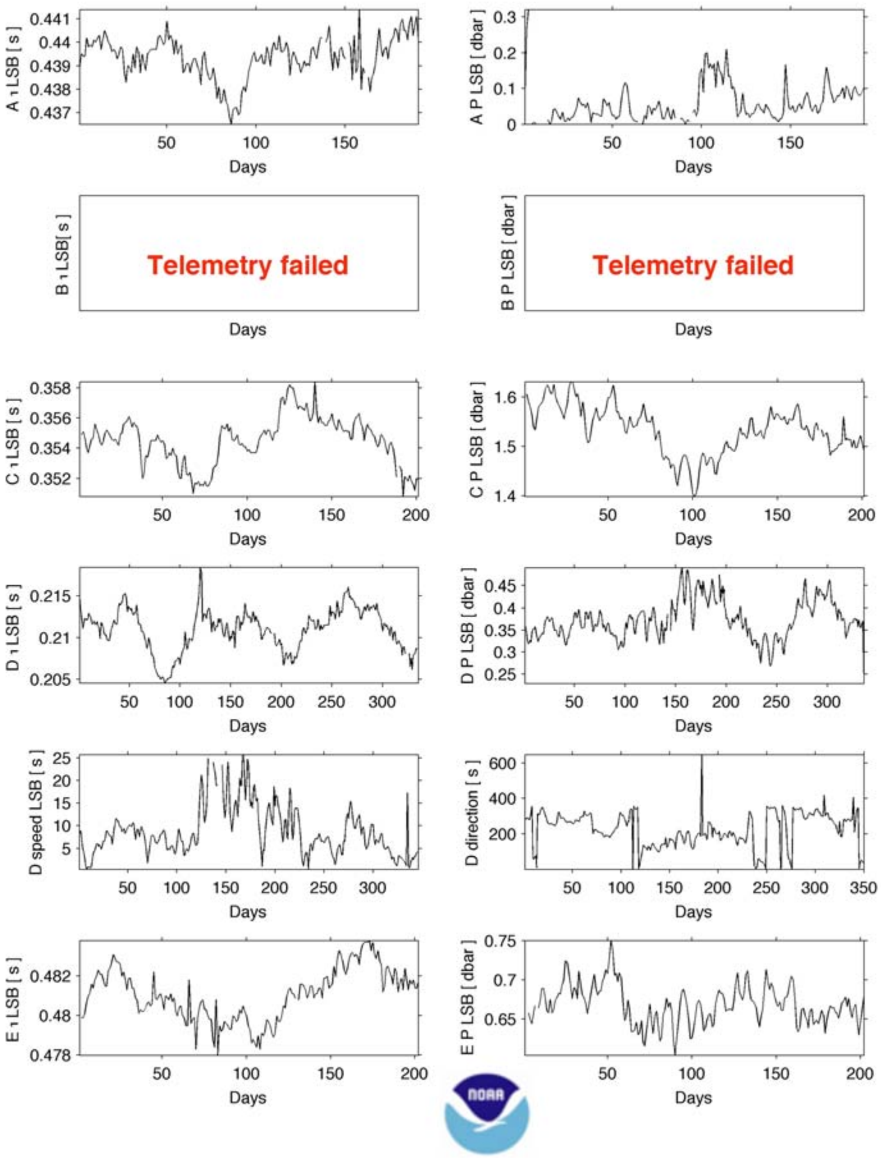


Figure 2: Raw time series of data collected via acoustic telemetry from the PIES and CPIES during this cruise. Capital letters on the left axes denote the mooring names (see Table 1 for locations). Values plotted are travel time (τ) and pressure (P), as well as speed and direction for the CPIES at Site D.

Preliminary sections of hydrographic data:
This section presents the preliminary temperature, salinity, oxygen and density (sigma-t) sections from the CTD measurements as well as the absolute zonal and meridional velocities determined by the LADCP.

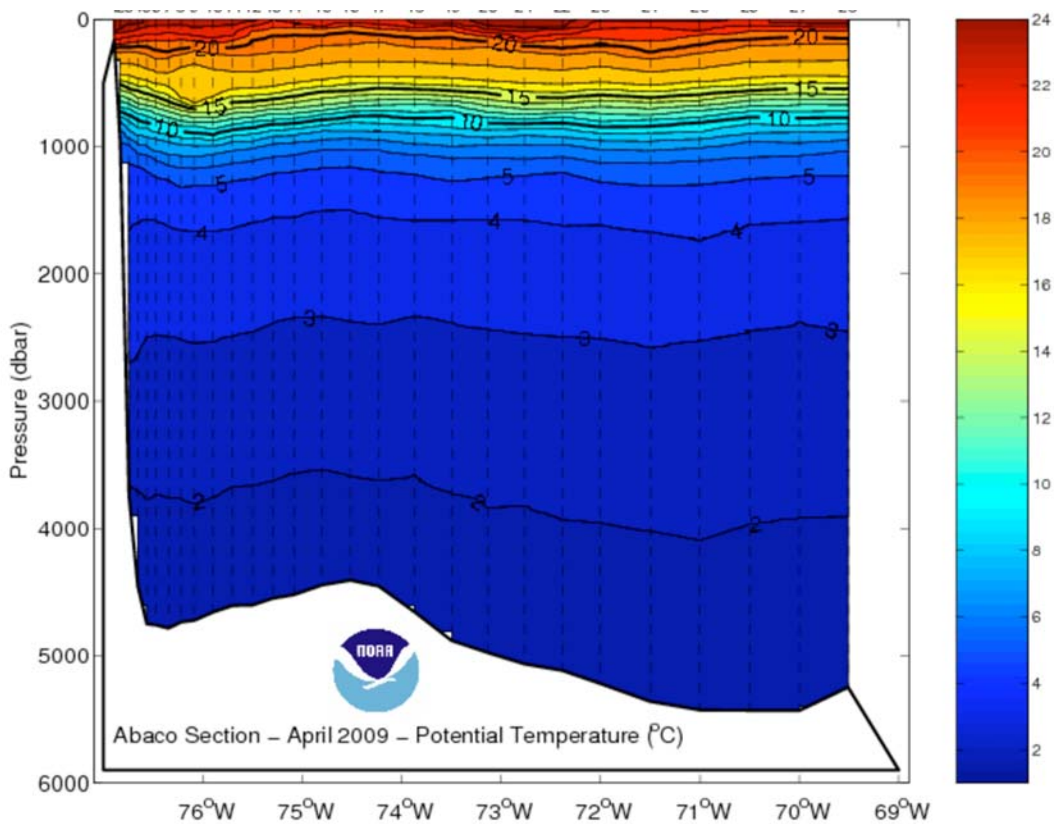
Sections are presented herein in the following order:

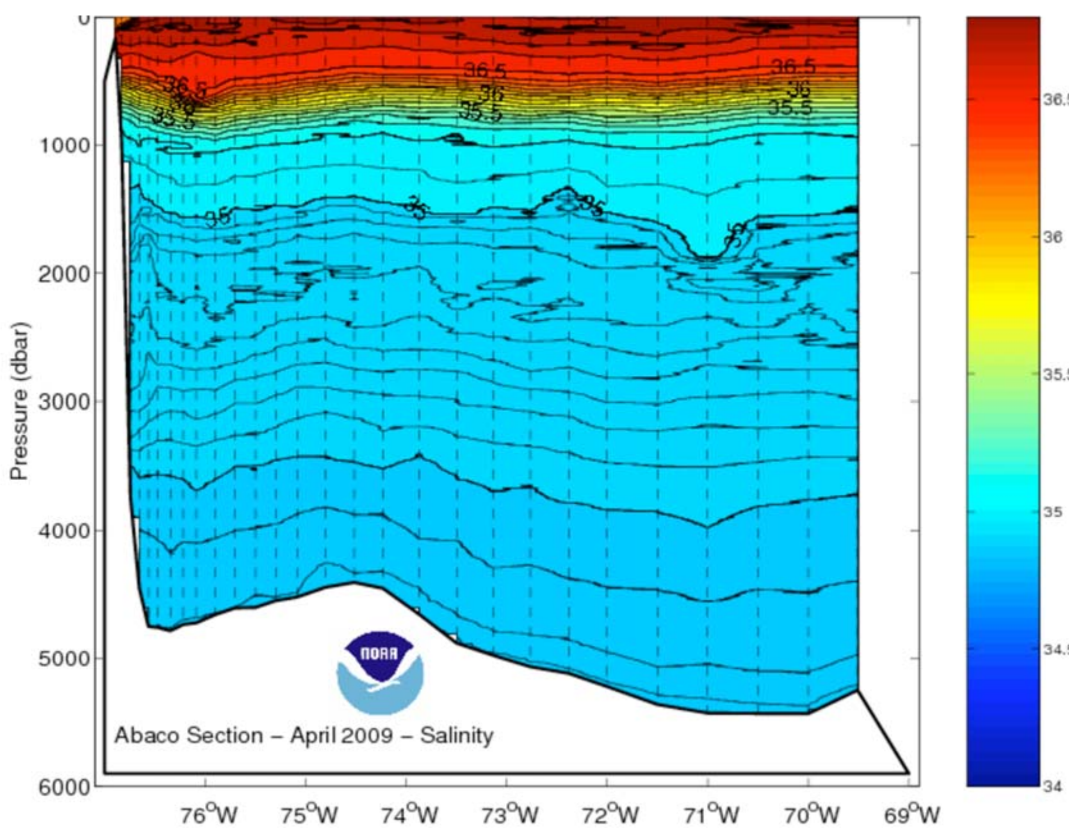
Abaco section:
- Temperature (potential)
- Salinity
- Oxygen
- Density (sigma-t)
- Bottle trip locations
- LADCP zonal velocity
- LADCP meridional velocity

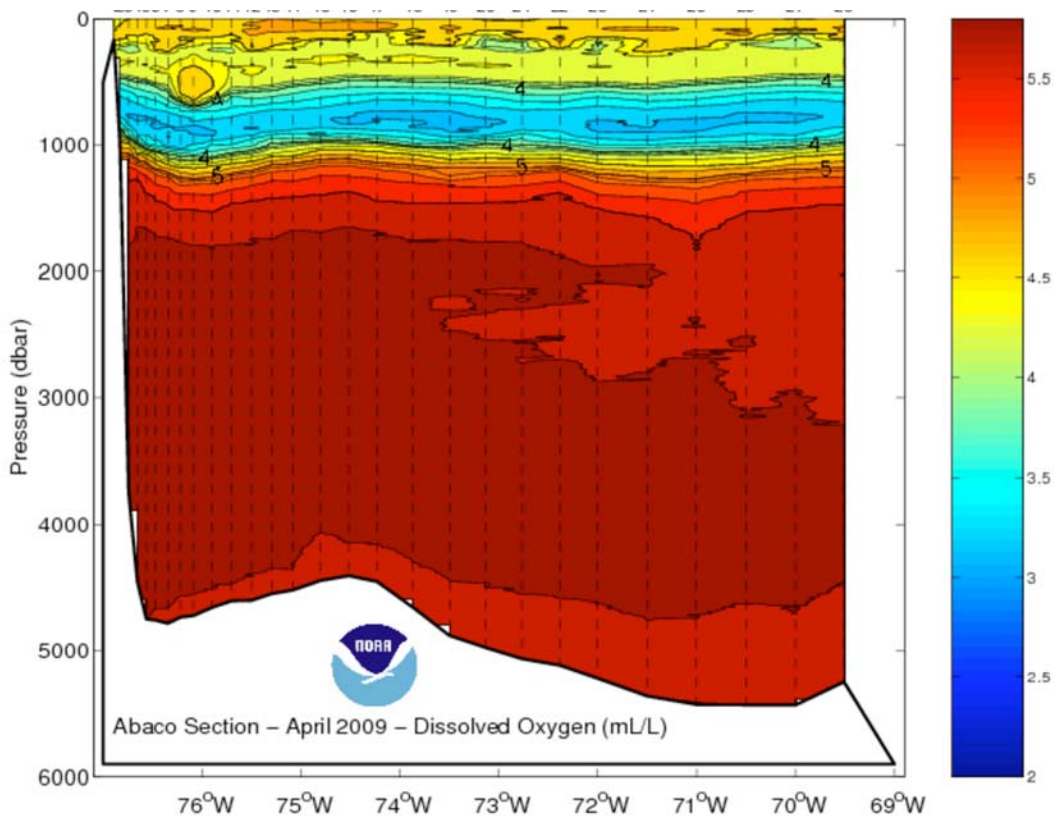
Northwest Providence Channel section:
- Temperature (potential)
- Salinity
- Oxygen
- Density (sigma-t)
- Bottle trip locations
- LADCP zonal velocity
- LADCP meridional velocity

Florida Straits 26°N section:
- Temperature (potential)
- Salinity
- Oxygen
- Density (sigma-t)
- Bottle trip locations
- LADCP zonal velocity
- LADCP meridional velocity

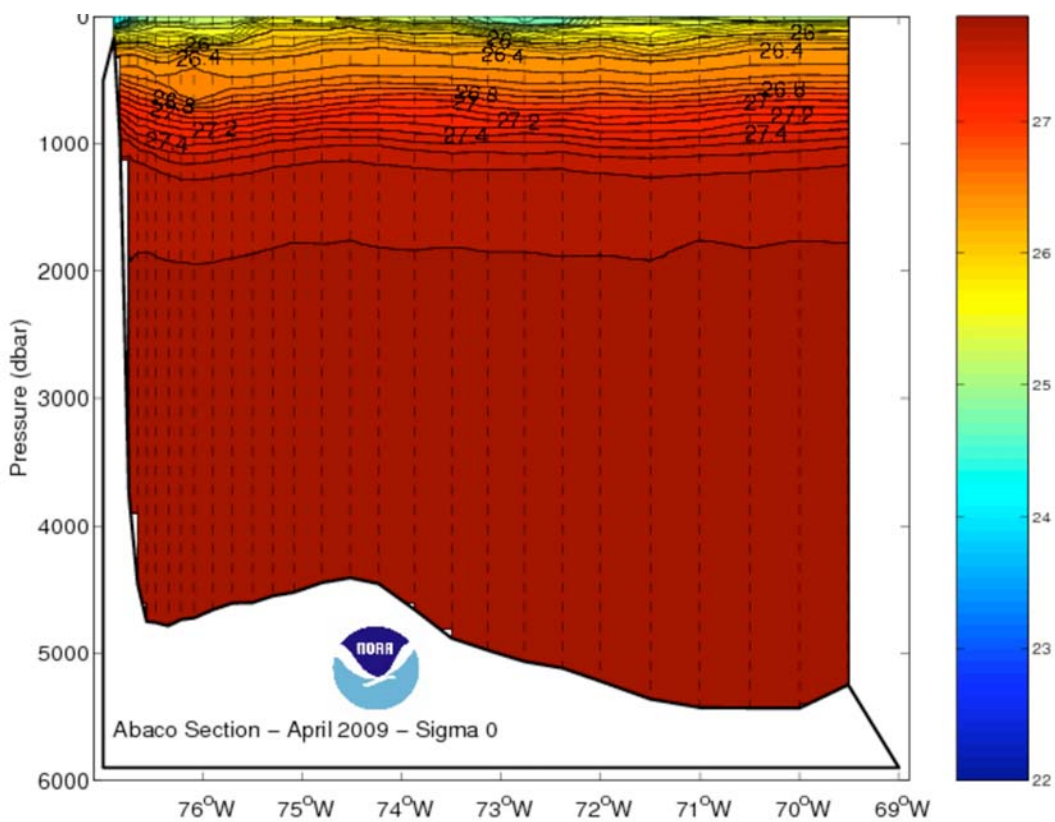
Florida Straits 27°N section:
- Temperature (potential)
- Salinity
- Oxygen
- Density (sigma-t)
- Bottle trip locations
- LADCP zonal velocity
- LADCP meridional velocity


Abaco Section – April 2009 – Potential Temperature (°C)
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W
24
22
20
18
16
14
12
10
8
6
4
2

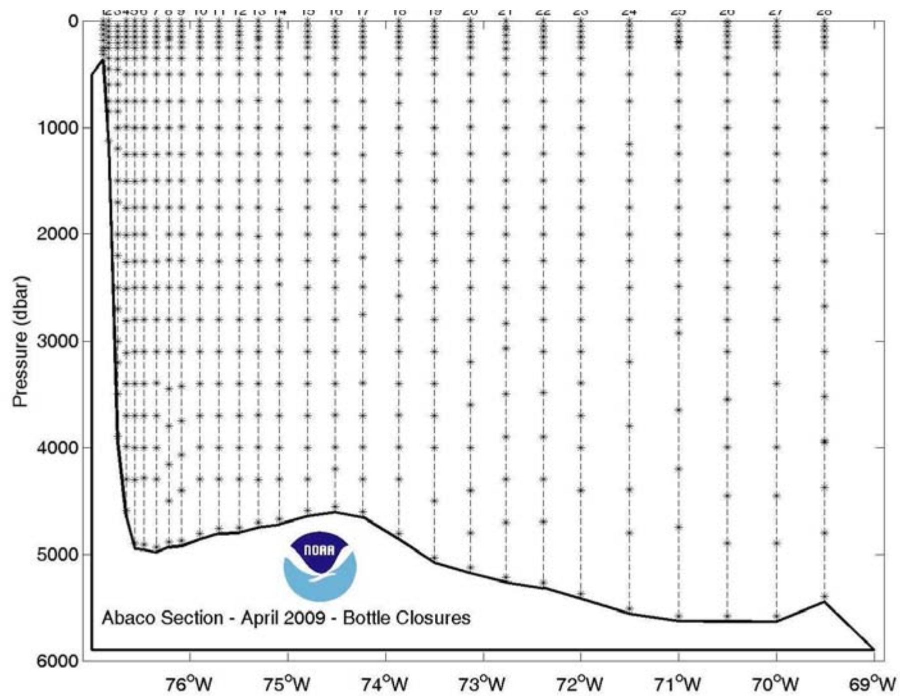

Abaco Section – April 2009 – Salinity
Pressure (dbar)
1000
2000
3000
4000
5000
6000
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W
36.5
36
35.5
35
34.5
34



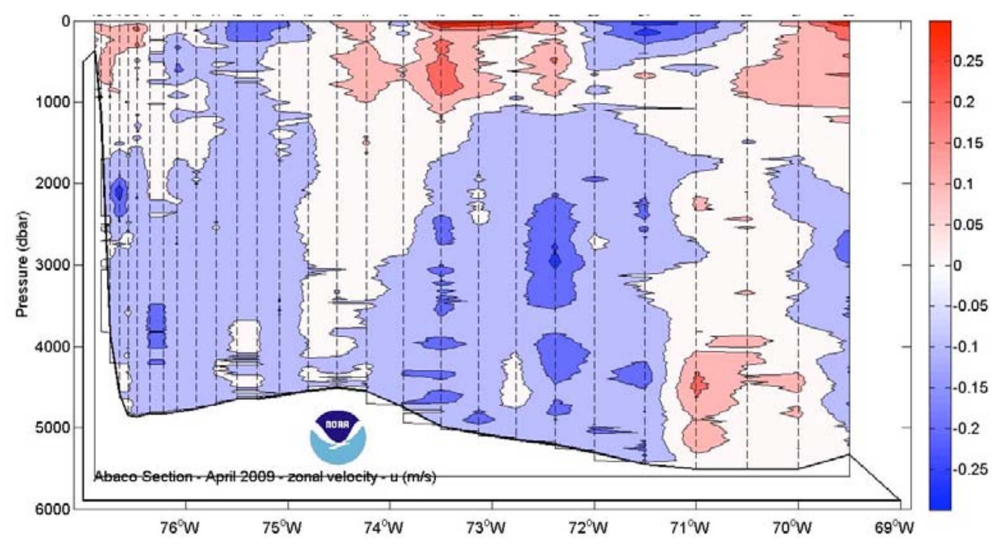
Pressure (dbar)
Abaco Section – April 2009 – Dissolved Oxygen (mL/L)
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W



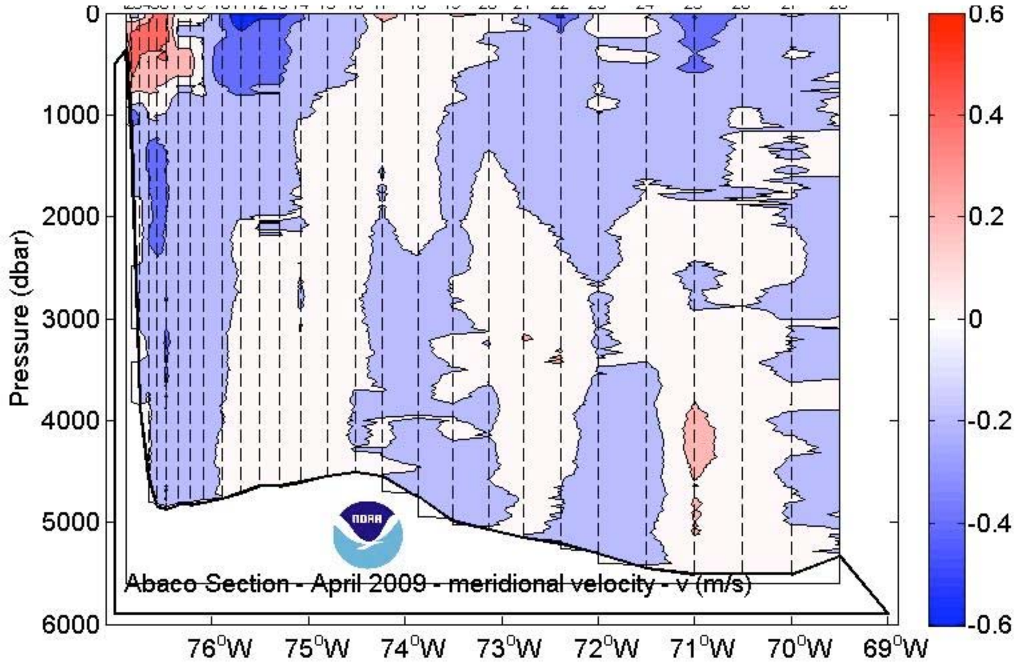
Pressure (dbar)
Abaco Section – April 2009 – Sigma 0
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W

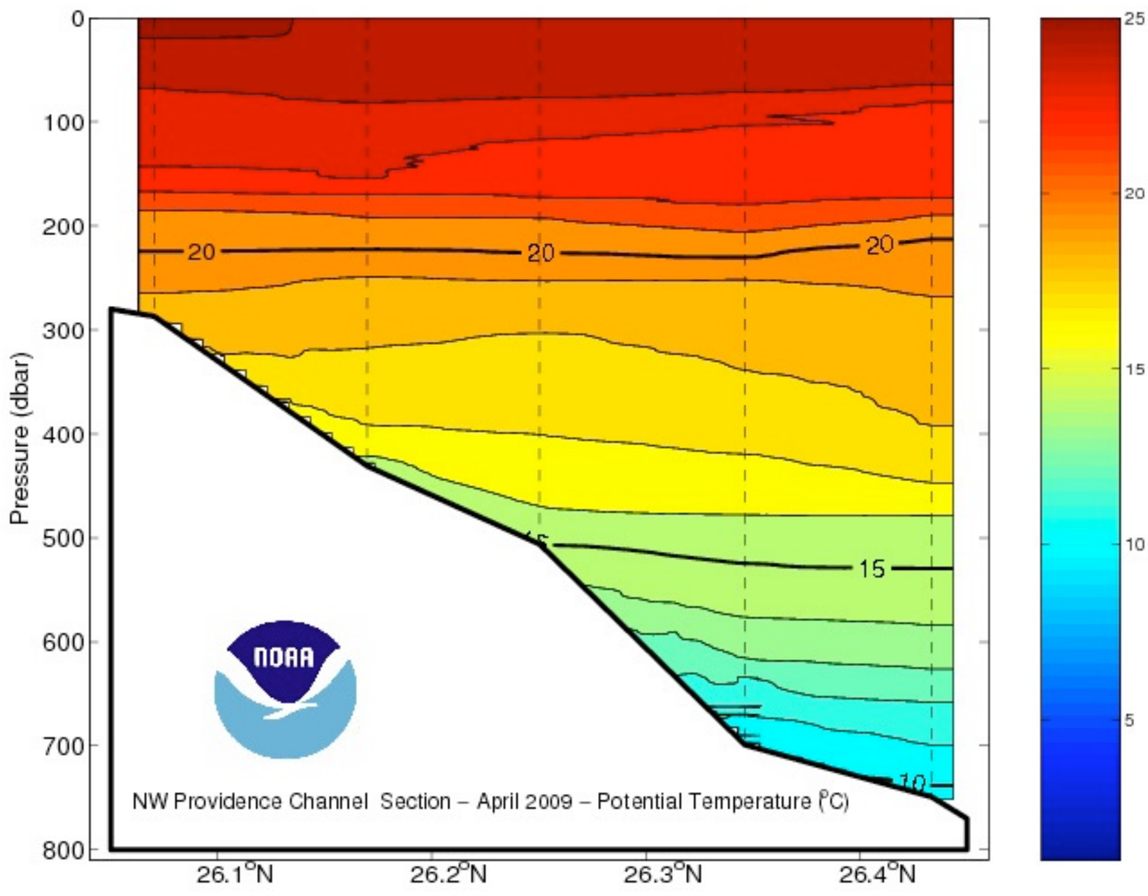


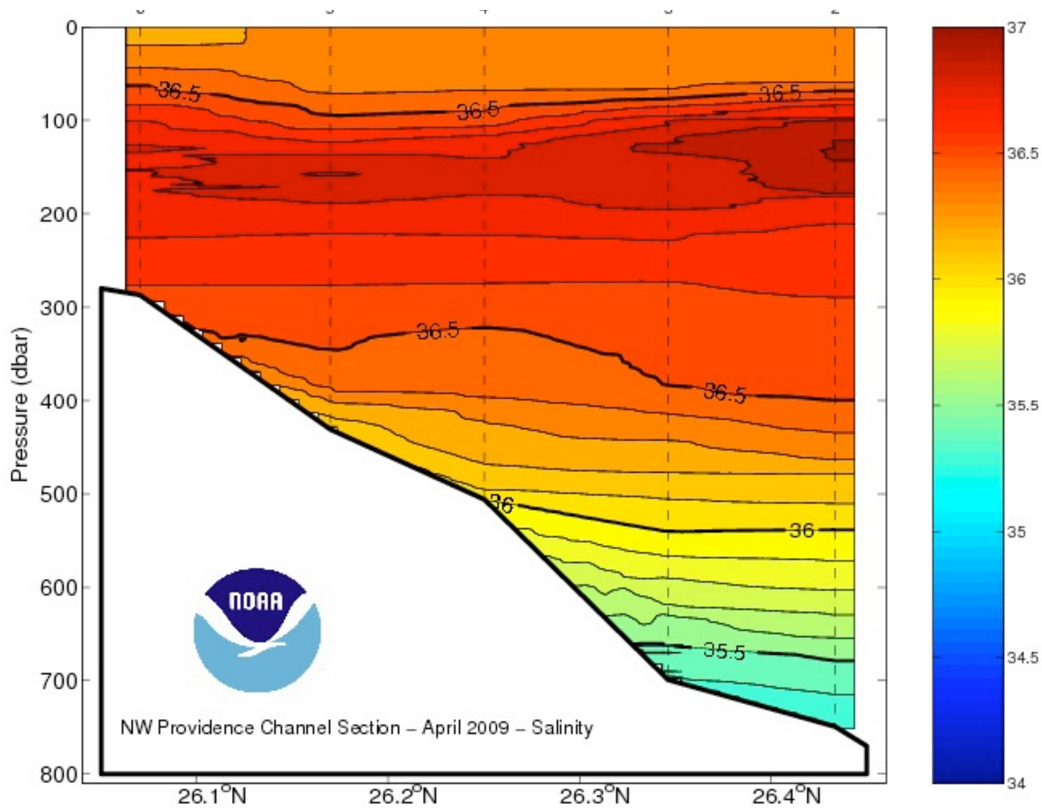
Pressure (dbar)
Abaco Section - April 2009 - Bottle Closures
0
1000
2000
3000
4000
5000
6000
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W

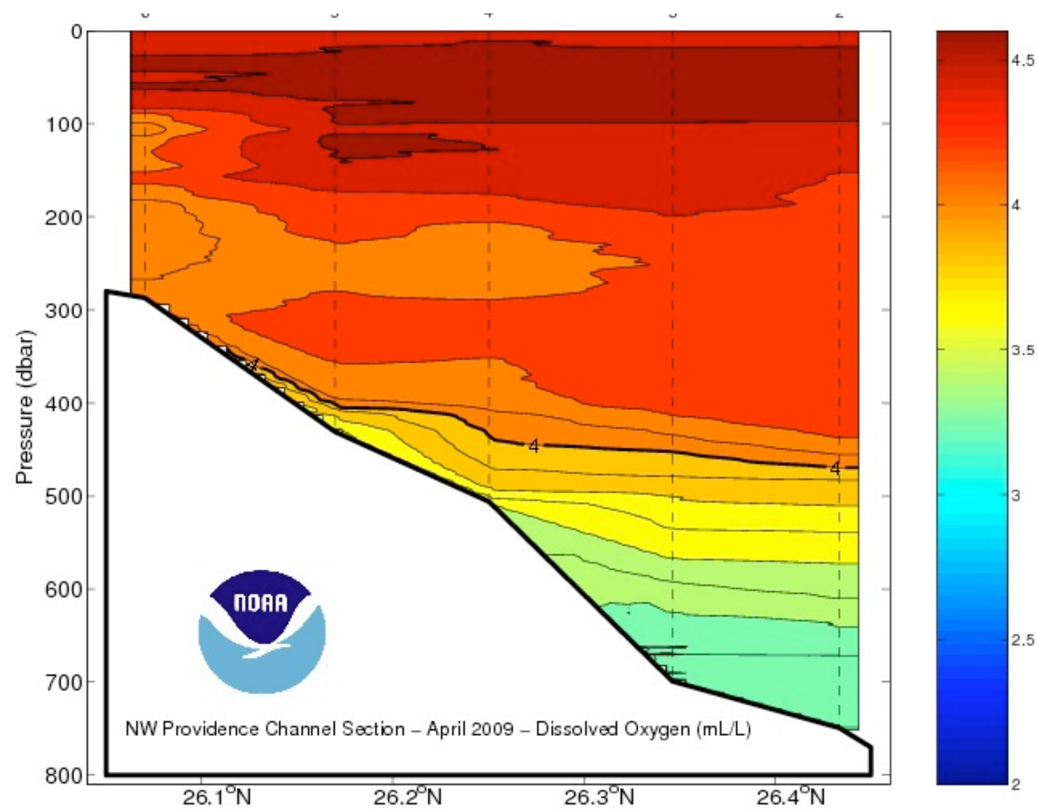


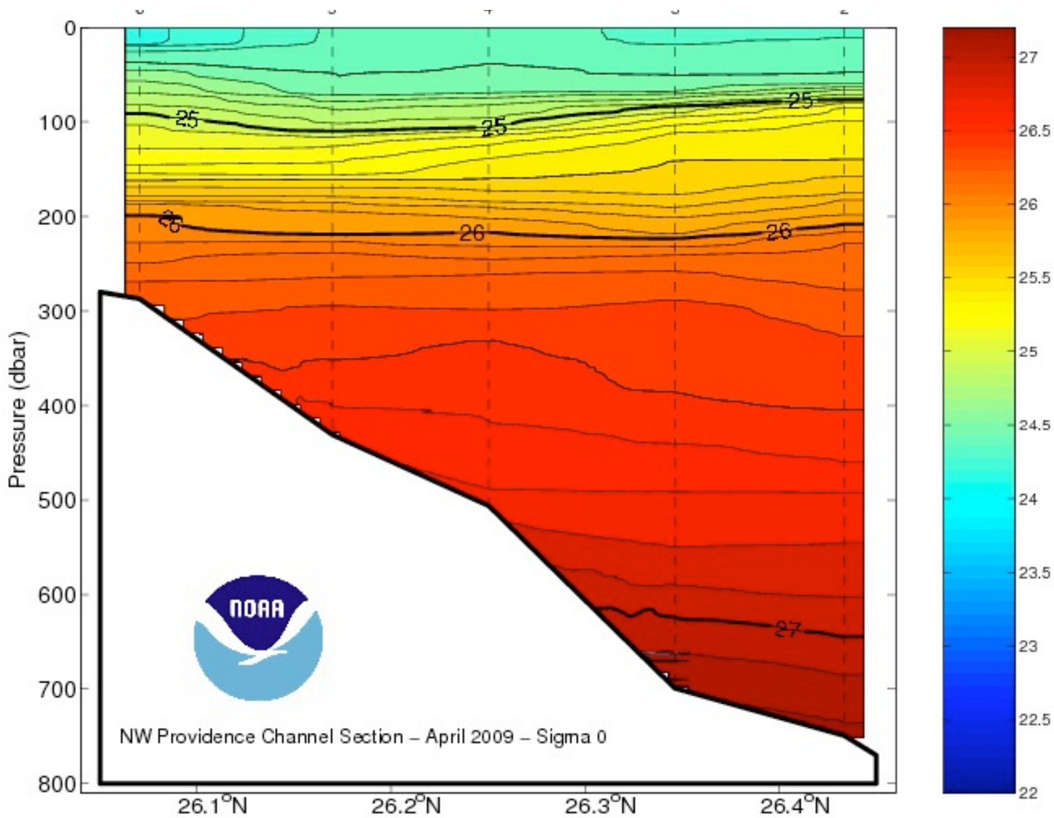
Pressure (dbar)
Abaco Section - April 2009 - zonal velocity - u (m/s)
0
1000
2000
3000
4000
5000
6000
76°W
75°W
74°W
73°W
72°W
71°W
70°W
69°W
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25


Abaco Section - April 2009 - meridional velocity - v (m/s)
Pressure (dbar)
76°W 75°W 74°W 73°W 72°W 71°W 70°W 69°W
0.6 0.4 0.2 0 -0.2 -0.4 -0.6

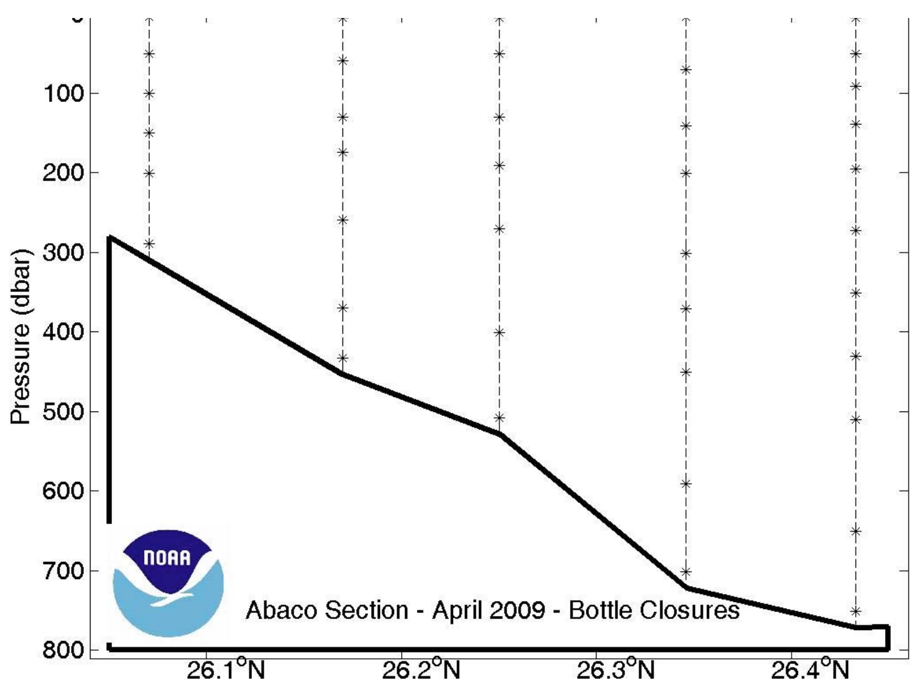

NW Providence Channel Section – April 2009 – Potential Temperature (°C)
Pressure (dbar)
26.1°N 26.2°N 26.3°N 26.4°N
25 20 15 10 5


Pressure (dbar)
26.1°N
26.2°N
26.3°N
26.4°N
36.5
36
35.5
NW Providence Channel Section – April 2009 – Salinity
37
36.5
36
35.5
35
34.5
34

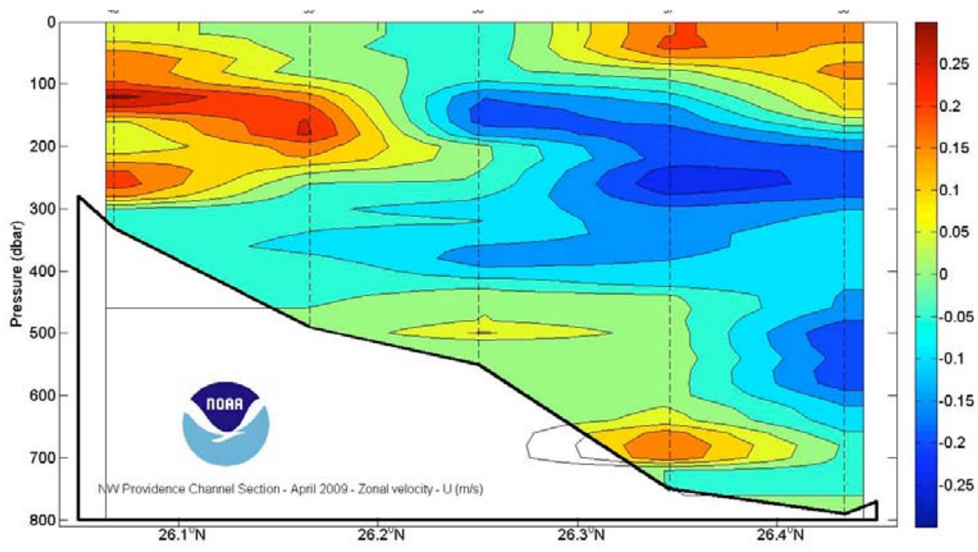

Pressure (dbar)
26.1°N
26.2°N
26.3°N
26.4°N
4
NW Providence Channel Section – April 2009 – Dissolved Oxygen (mL/L)
4.5
4
3.5
3
2.5
2



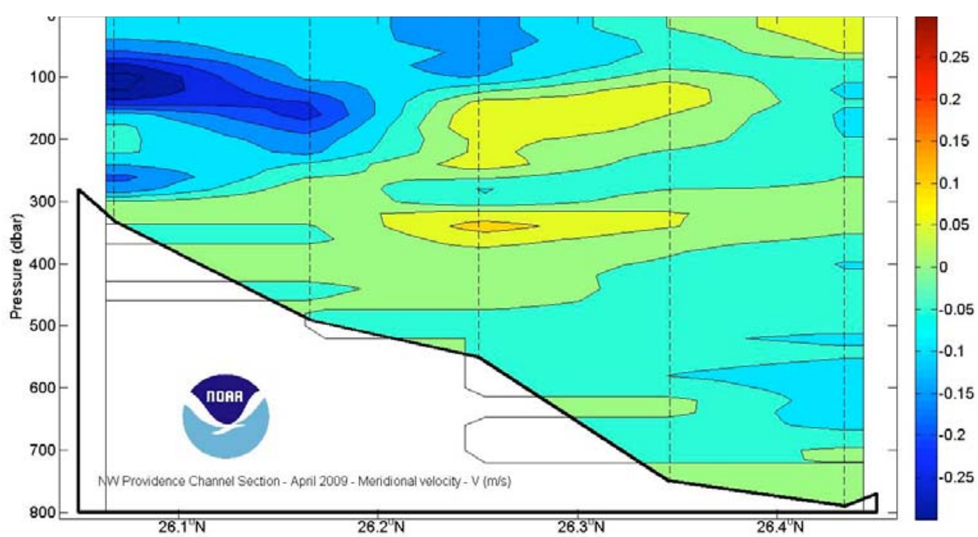
NW Providence Channel Section – April 2009 – Sigma 0
Pressure (dbar)
26.1°N
26.2°N
26.3°N
26.4°N



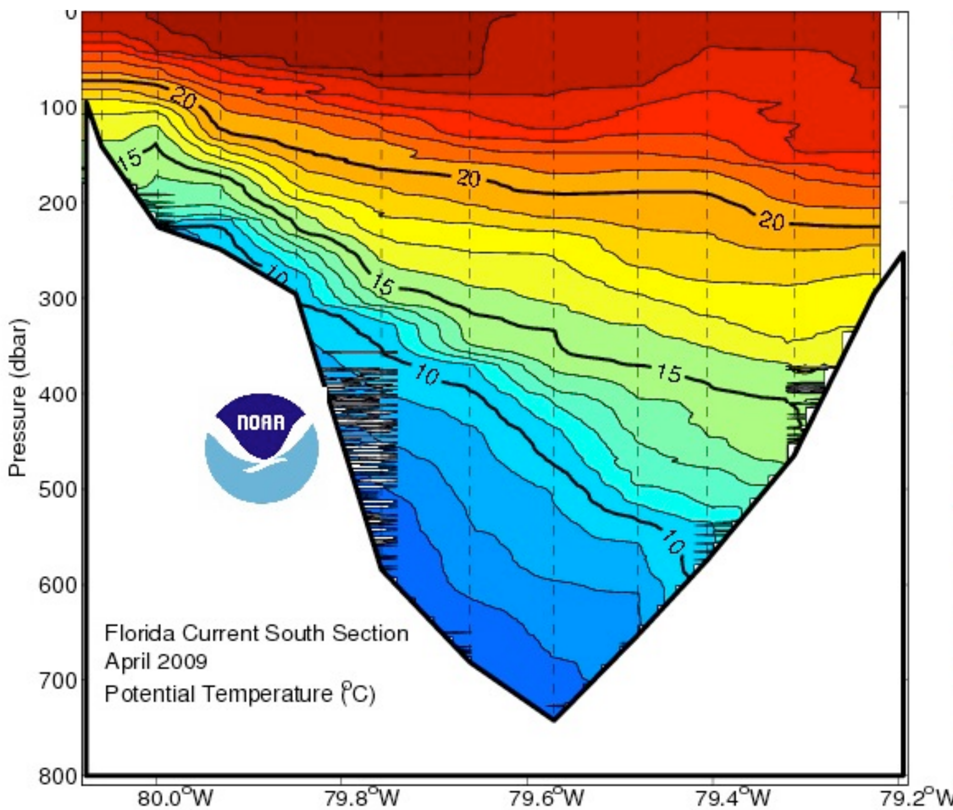
Abaco Section - April 2009 - Bottle Closures
Pressure (dbar)
26.1°N
26.2°N
26.3°N
26.4°N

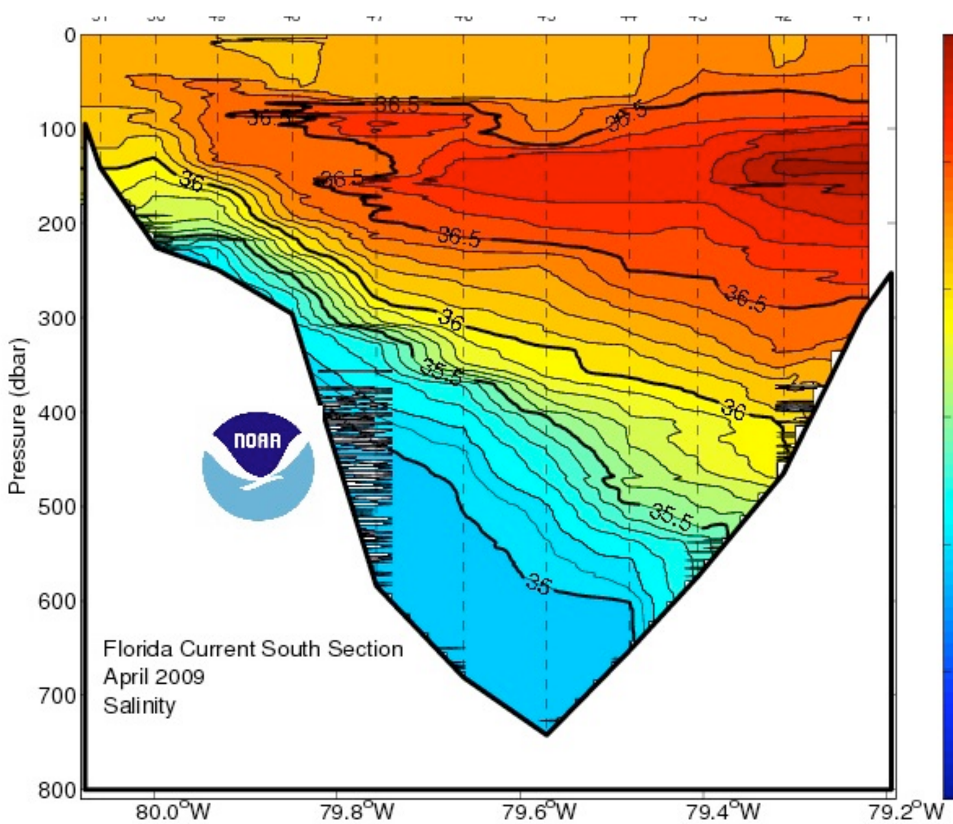


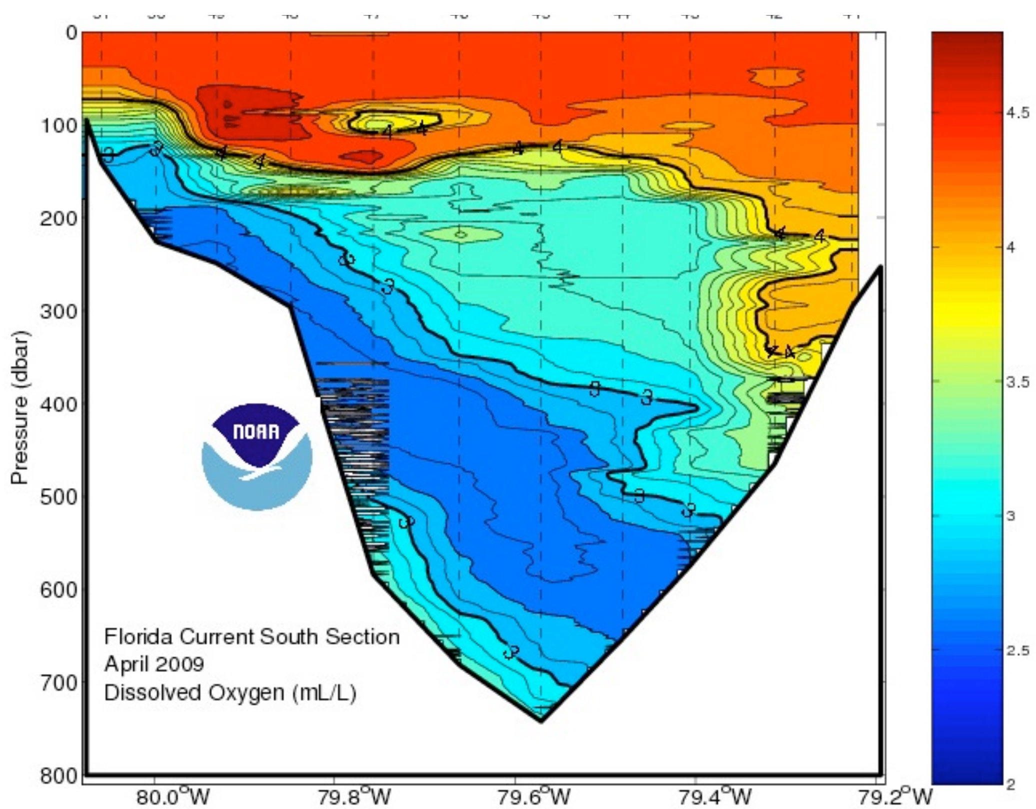
Pressure (dbar)
NW Providence Channel Section - April 2009 - Zonal velocity - U (m/s)
26.1°N
26.2°N
26.3°N
26.4°N

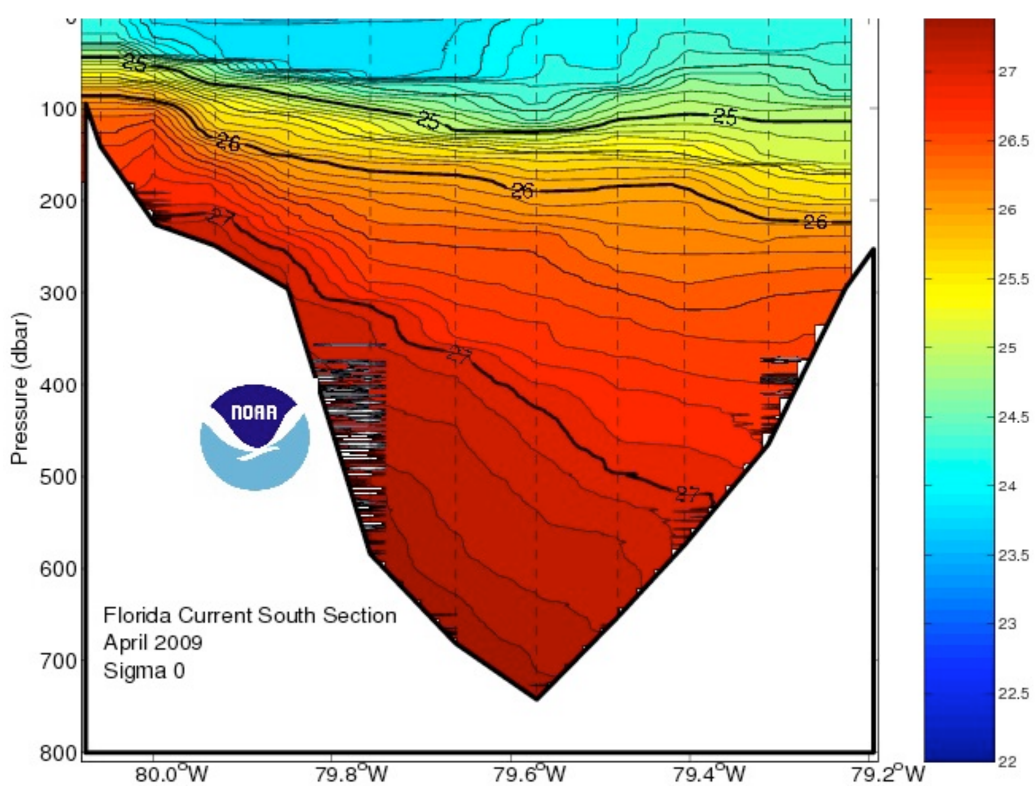


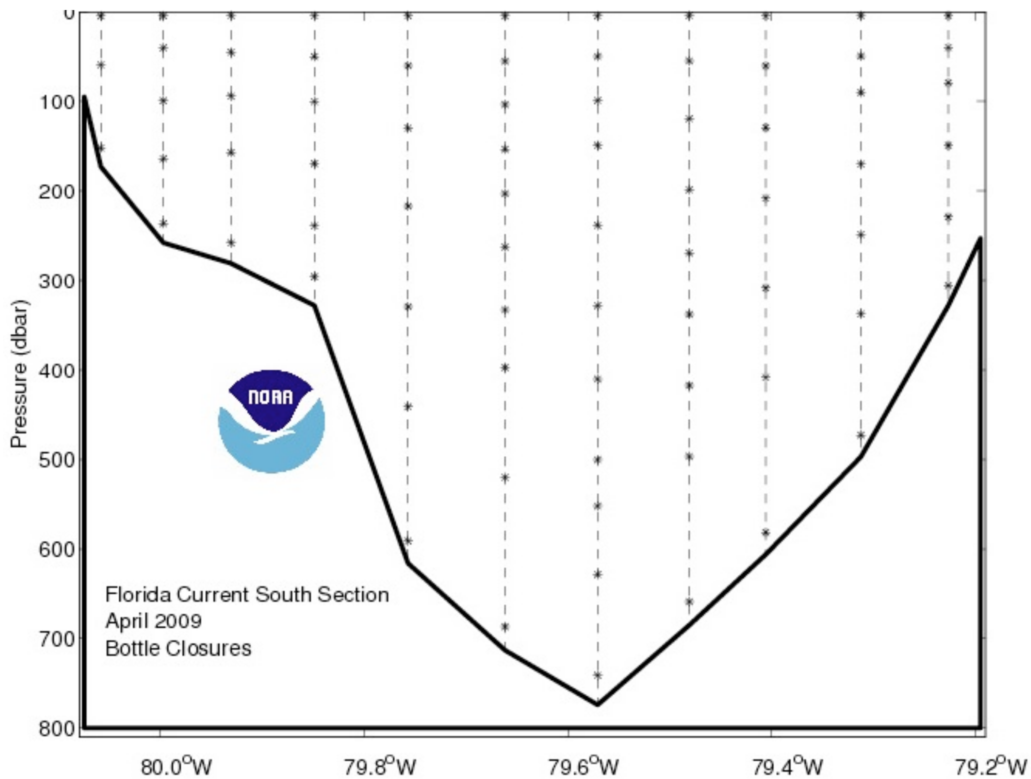
Pressure (dbar)
NW Providence Channel Section - April 2009 - Meridional velocity - V (m/s)
26.1°N
26.2°N
26.3°N
26.4°N

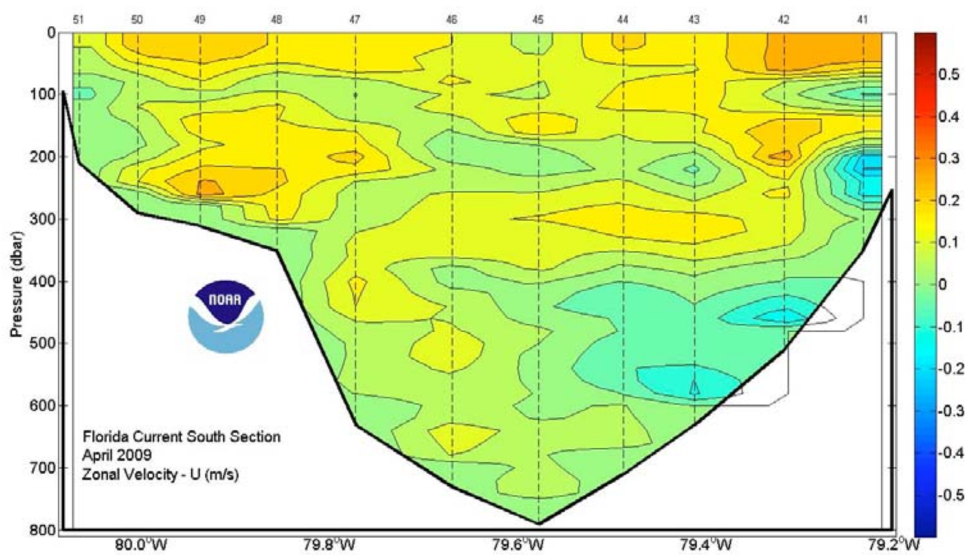

Florida Current South Section
April 2009
Potential Temperature (°C)
Pressure (dbar)
0
100
200
300
400
500
600
700
800
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W
20
15
10
25
5
NOAA

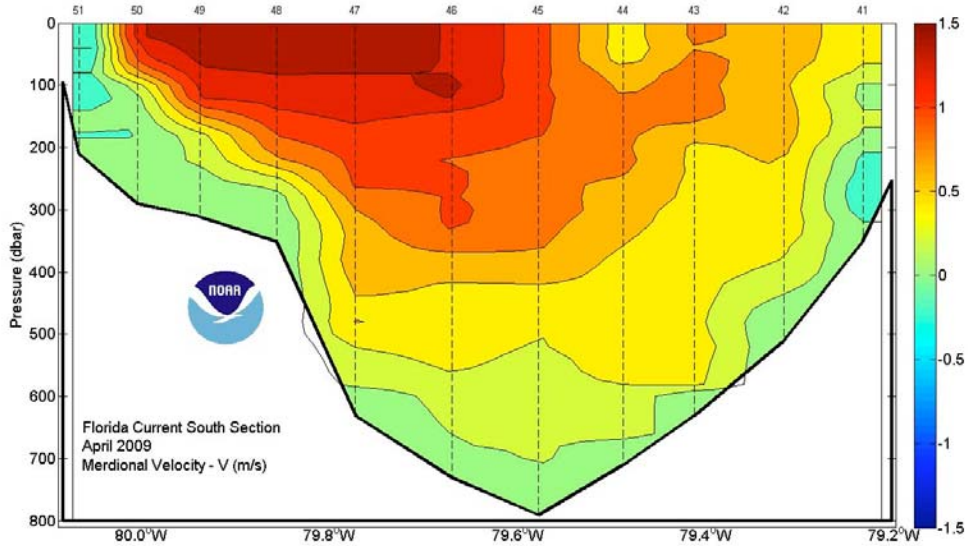

Florida Current South Section
April 2009
Salinity
Pressure (dbar)
0
100
200
300
400
500
600
700
800
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W
36.5
36
35.5
35
37
34.5
34
NOAA

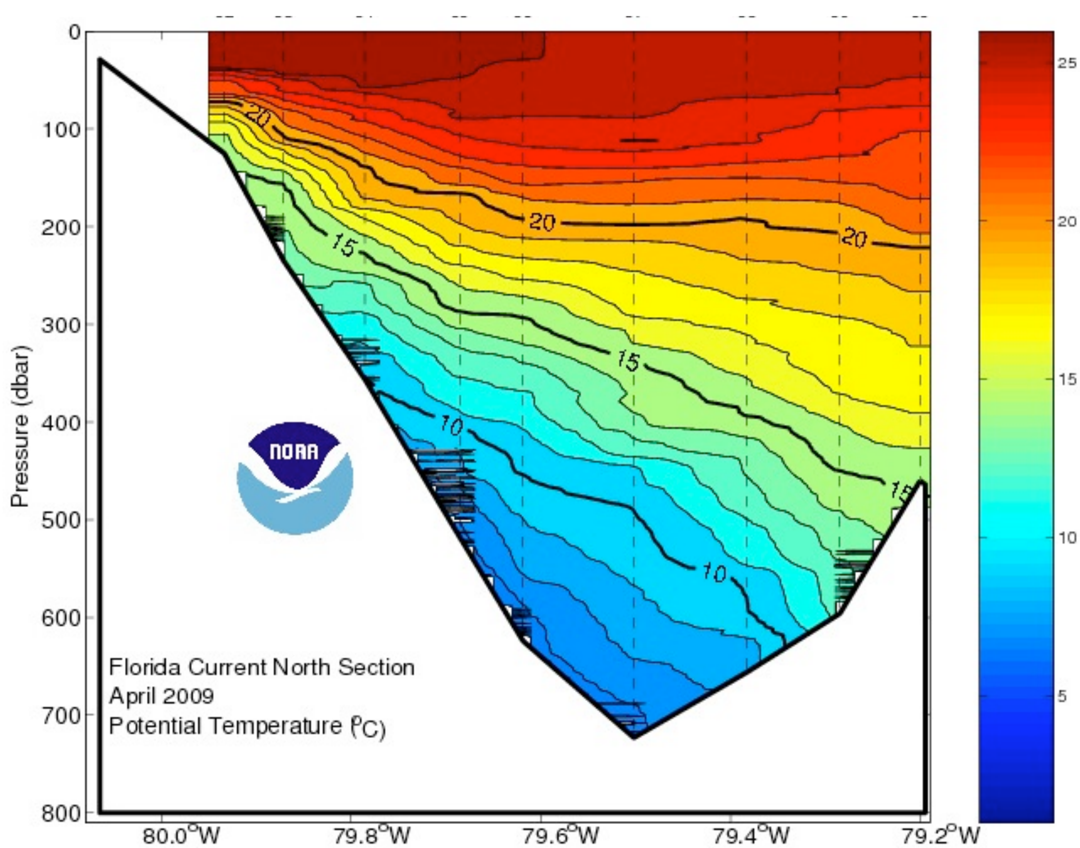

Pressure (dbar)
Florida Current South Section
April 2009
Dissolved Oxygen (mL/L)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

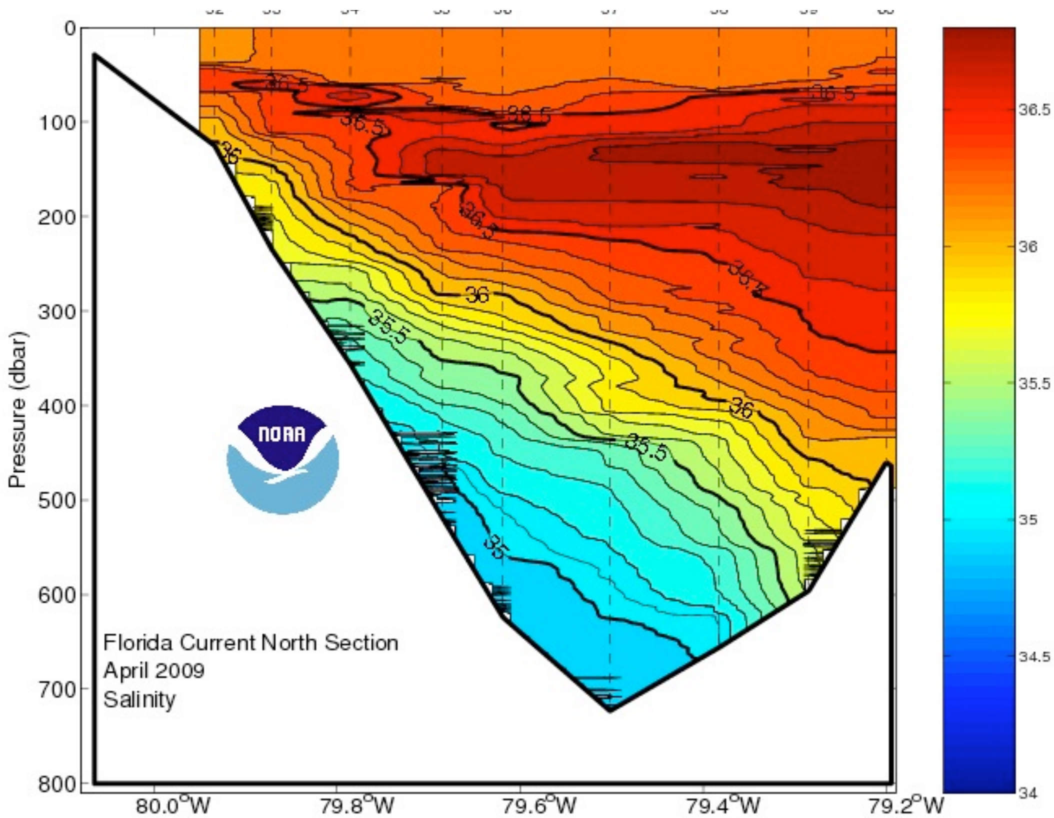

Pressure (dbar)
Florida Current South Section
April 2009
Sigma 0
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

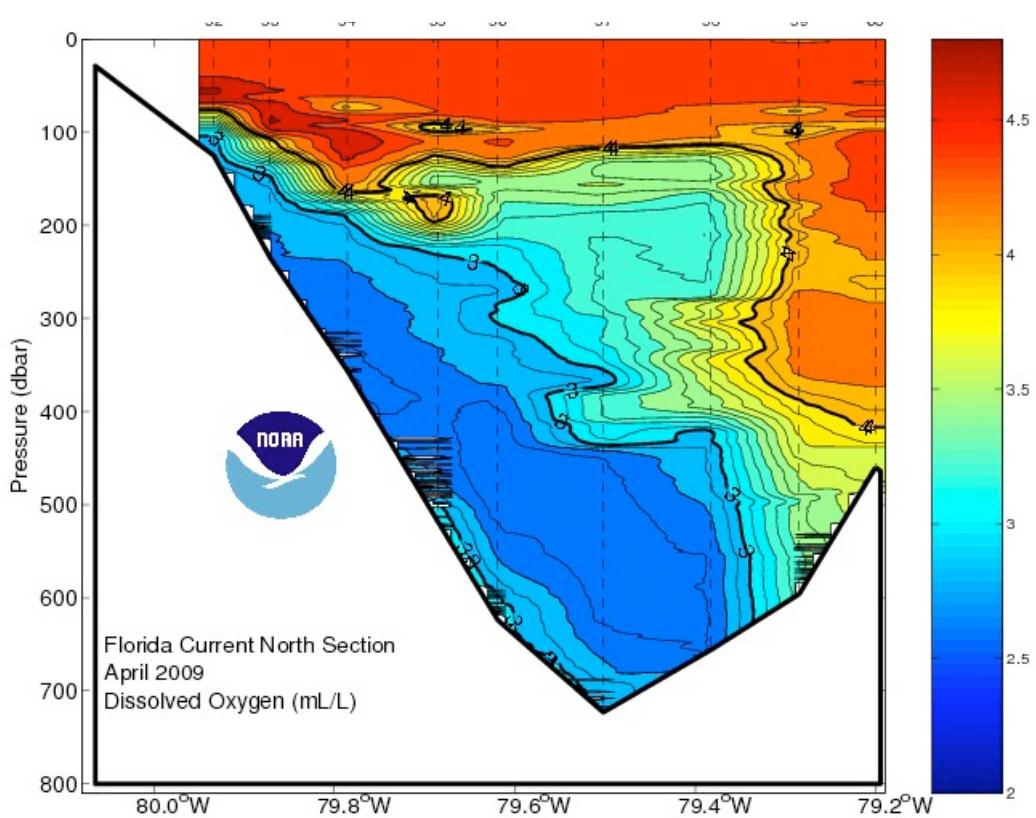

Pressure (dbar)
Florida Current South Section
April 2009
Bottle Closures
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

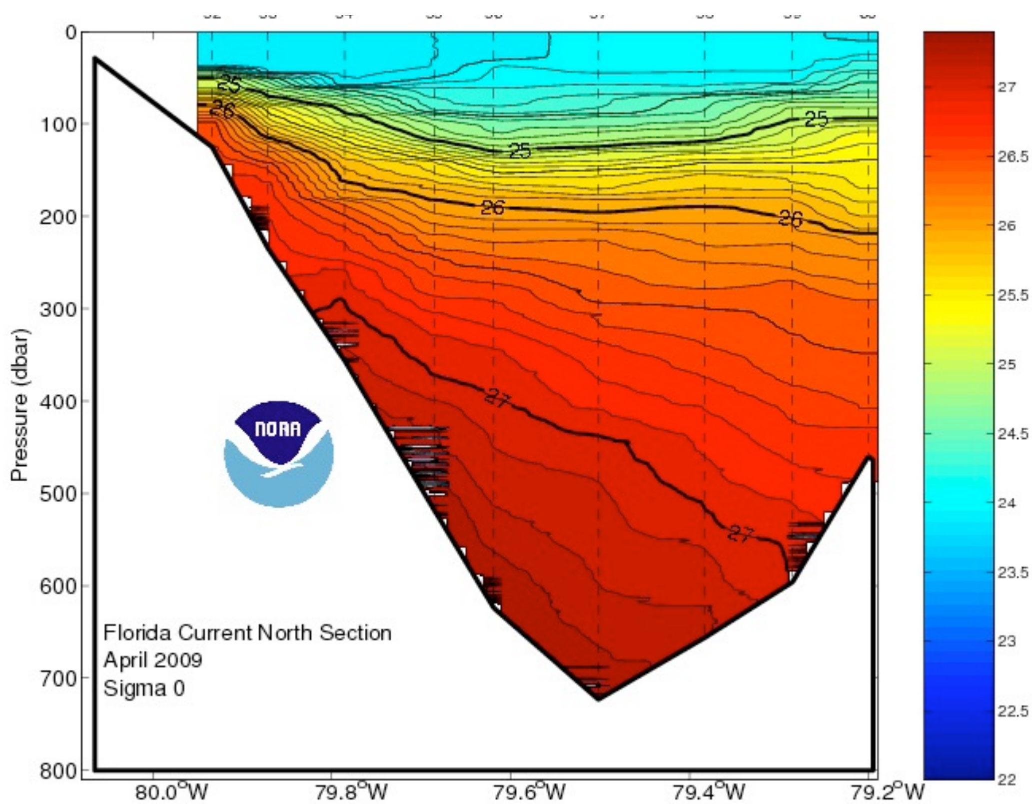

51
50
49
48
47
46
45
44
43
42
41
Pressure (dbar)
Florida Current South Section
April 2009
Zonal Velocity - U (m/s)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W


51
50
49
48
47
46
45
44
43
42
41
Pressure (dbar)
Florida Current South Section
April 2009
Merdional Velocity - V (m/s)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

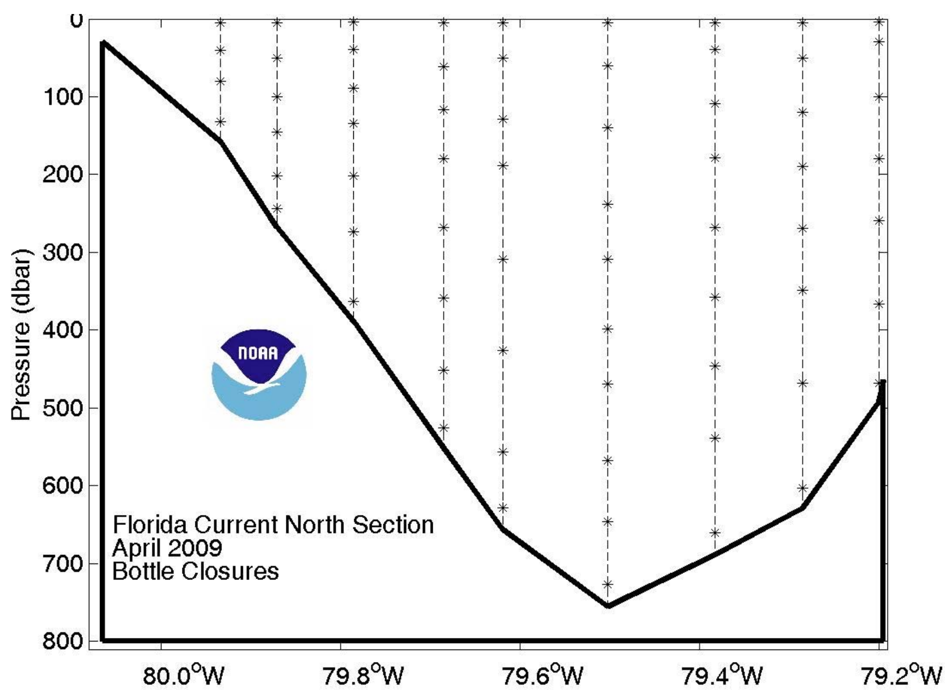

Pressure (dbar)
Florida Current North Section
April 2009
Potential Temperature (°C)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W


Florida Current North Section
April 2009
Salinity
Pressure (dbar)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

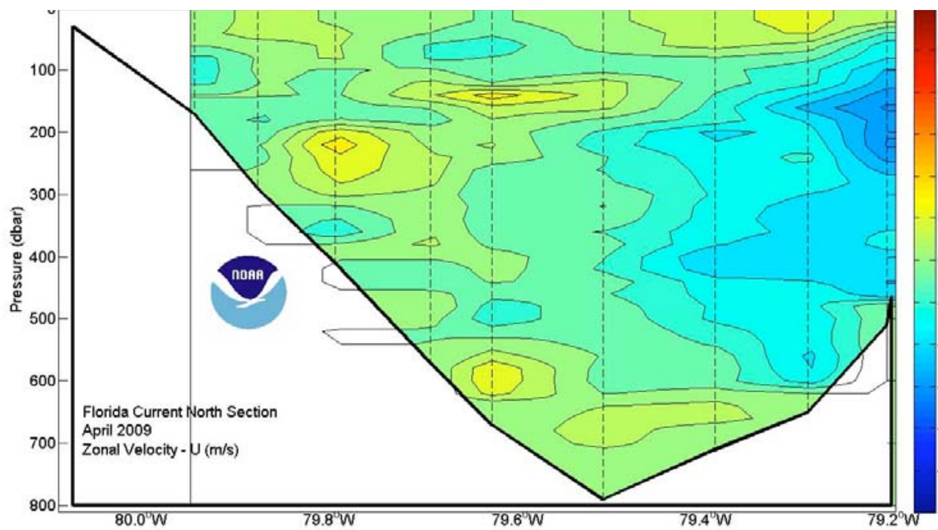

Florida Current North Section
April 2009
Dissolved Oxygen (mL/L)
Pressure (dbar)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W

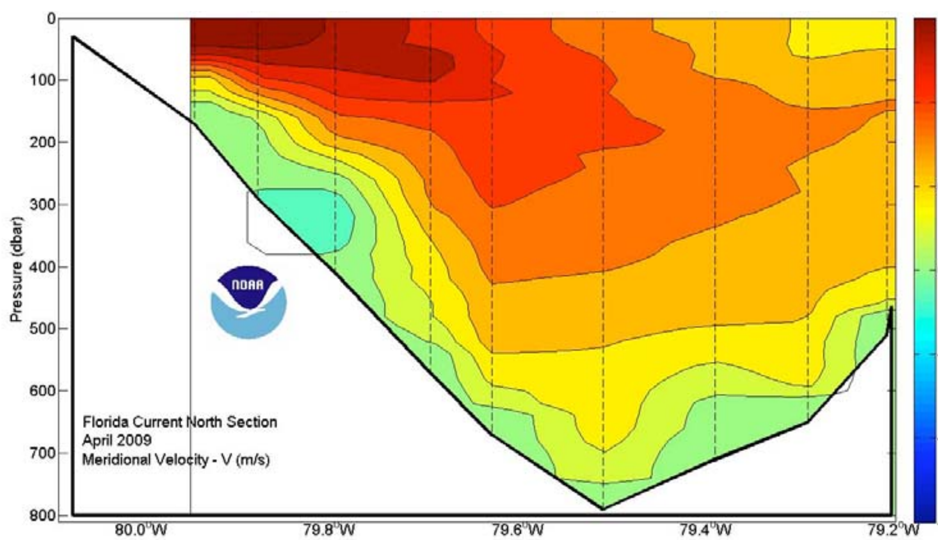


Pressure (dbar)
Florida Current North Section
April 2009
Sigma 0
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W



Pressure (dbar)
Florida Current North Section
April 2009
Bottle Closures
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W


Pressure (dbar)
Florida Current North Section
April 2009
Zonal Velocity - U (m/s)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W
NOAA


Pressure (dbar)
Florida Current North Section
April 2009
Meridional Velocity - V (m/s)
80.0°W
79.8°W
79.6°W
79.4°W
79.2°W
NOAA

CTD operations report

Personnel: Carlos Fonseca, Wendy Saintval, Andy Stefanick, Kyle Seaton, Christopher Meinen, Pedro Pena, Ben Shaw, Emma Heslop

A total of 61 CTD profiles were completed during the April-May 2009 Western Boundary Time Series cruise (AB0904).

The following list of sensors were used in the setup of the CTD system:

CTD SN#768 (CTD SN#363 was used on station#0)

Primary Temperature SN#4799	Secondary Temperature SN#2958
Primary Conductivity SN#2980	Secondary Conductivity SN#1346
Primary Oxygen SN#1348	Secondary Oxygen SN#154

During the test cast CTD SN#363 was used, however it was determined that the on-deck pressure prior to the cast for that sensor was much too high (6.3 dbar). Because this value was so large compared to previous values when this CTD was used, we decided that we would swap in a different CTD unit (CTD SN#768). Subsequent to this cast, the same CTD equipment was used for the entire cruise, as there were few problems with the equipment.

As with most cruises, we had a smattering of minor problems such as snagged lanyards resulting in Niskin bottle closure failures, occasional modulo errors, failed Niskin o-rings, and so forth. Only two more significant problems developed with the CTD system during the cruise. During casts 1-5 or so, the 0.322 CTD wire (sea-cable) on the forward winch was having wrap problems and the package had to be raised and lowered small distances when it was near the deepest point in the cast before the package could be brought up in order to improve the wire wrapping. After several deep casts this problem went away.

The most significant issue first became a problem with CTD station#30. During this cast, which was one of the calibration dip casts for the UK microcat sensors, the CTD recorded 217 modulo errors. The next day during the next microcat dip cast (CTD station#31) a total of 114 modulo errors were recorded. The nature of the problem was not immediately obvious because the modulo errors all occurred only on the upcast, only when the package was near 2500-3000 dbar (on 4800 dbar casts) and only when the package was moving (i.e. not during the 5 minute bottle stops). As a first effort to solve the problem we reseated nearly all of the connections on the package (e.g. sea cable, sensor cables) and the ship ET (Jeff Hill) switched the com-ports on the back of the deck unit for the carousel and communications. On the subsequent cast (CTD station

#32) there was only 1 modulo error, which may have been due to on-the-fly changing of the Seabird software to account for the com-port changes (which had been forgotten prior to starting the cast). The next cast (CTD station#33) had no modulo errors.

On CTD station#34 the modulo error problem returned with a vengeance, with more than 300 modulo errors (again only in the 2500-3000 dbar range, only on the up-cast, and only when the package was moving). The sea cable connection was reseated again by Jonathan Shannahoff and on the subsequent cast (CTD station#35) only 14 modulo errors were observed (same pattern as the previous cast). The next morning it was found that the cable to the water sampler/carousel had not been reseated with all of the other cables a few days earlier. When the connection was pulled off, water was found inside the connector and the grease had turned yellow. Cleaning and reseating this cable appeared to have solved the problem through the end of the Northwest Providence Channel section, although all of the remaining casts were in much shallower water (less than 800 dbar), which may also explain the reason for the improved performance.

On CTD station#43 modulo errors began returning again in a small number (9) despite the cast being fairly shallow (<800 dbar), and on CTD station#44 there were 28 modulo errors and more importantly there were about a half-dozen significant spikes in the pressure, temperature, and salinity. The best guess at this point was that there was an electrical contact problem in either the termination or the sea cable itself, or an electrical problem in the CTD fish or in the deck unit. None of these sources of error specifically lent themselves to the exact conditions we were observing. Because the aft winch wire was already terminated and ready to use, the decision was made to swap from the forward winch drum carrying 0.322 wire to the aft winch drum carrying a new spool of 0.375 wire. Approximately one hour was required to switch over from the 0.322 wire to the 0.375 wire. During the quick testing of the new 0.375 wire a file was created as CTD station#45, however that file contains only on-deck data. The actual cast done was called CTD station#45A. The files for station #45 were deleted after the casts and the station#45A files were renamed as station#45. The subsequent casts along the 26°N CTD section in the Straits of Florida and during the 27°N did not have any modulo errors, which confirms that the problem was either in the termination or in the sea-cable (because the same CTD fish and deck unit were used with the new wire).

On CTD station#43 it appears that something was causing the Primary Oxygen and Conductivity sensors to offset from the Secondary sensors in the upper 40-50 dbar (O_2 was about 1 ml/l low). The problem was flow-related, not an electronics problem with the sensors. Below 50 m the offsets/errors went away. The problem continued through CTD station#55 despite adjusting the tubing and changing the pump between sites. Between CTD stations#55 and 56 the flow tubes were flushed from the outlet and this solved the problem.

Overall the salinity bottle samples were extremely reliable, although a problem was observed with one batch of the salinity standard water (Batch 147) that had been brought onboard the ship. Also during the last few casts there was a mix-up during the day shift regarding some of the salinity samples and bottles that had already been filled with samples were erroneously emptied and filled with new samples prior to analysis. The problem affected fewer than a dozen samples. Throughout the cruise the temperature in the Autosal room was extremely steady.

Several fairly minor issues came up with regards to the oxygen sample titration. During the first few days of the hydrography work the temperature in the Bio-Analytical Lab varied significantly (from 55°F to 80°F). When the temperature got very high the first bottle of Thiosulfate being used in the titration processing developed condensation in the bottle. The small amount of Thio remaining in this bottle was deemed potentially unusable. The standardization runs using the second bottle of Thio (three attempts) provided calibration values that were consistent with one another but were at first deemed alarmingly different from the first bottle. Consultation with Robert Roddy and George Berberian at AOML indicated that the values were 'ok' albeit at the outside of the observed ranges previously observed in Carlos Fonseca's database. The third bottle of Thio produced values more similar to those found with the first. The dissolved oxygen values produced from the titrations found values very consistent with the electronic sensors.

The comparison between electronic sensors and bottle samples was deemed 'excellent' at the end of the cruise. The electronic sensor performance was so good they were considered 'within WOCE standards' even without calibration with the bottle samples.

IES Operations: April 2009

Personnel: Pedro Pena, Kyle Seaton, Andy Stefanick, Christopher Meinen

Acoustic telemetry was completed at four PIES/CPIES sites during the April 2009 Abaco cruise aboard the NOAA Ship Ronald H. Brown. The instruments had been deployed in either September 2008 (sites B, C, and E), in June 2008 (site A) or March 2006 (site D), and as such each contained either approximately 6, 9, or 36 months of data respectively. Because of earlier successful data downloads, data was only collected at site D back to March 2008; for sites A, C and E data was collected back to the start of the records. Telemetry was attempted at the B site however the instrument failed to respond. Note that the time in the "IES Laptop" computer was found to be off by more than 5 years – this was corrected prior to the PIES Site E download. Specific details for the IES operations at each site are as follows:

Site A: (PIES SN#159)

- Data was collected via telemetry from Site A twice during the cruise.
- Arrived on site for the first time April 18, 2009 at 17:00 GMT. CTD station #02 was commenced at the site prior to the start of telemetry.
- Data was downloaded initially with the "R2-D2" Benthos DS-7000 deck unit. We sent the telemetry command about 20 minutes before the 18:00 GMT sampling hour, however no data was received. We sent several additional TELEM commands with no clear response. After the sampling period the TELEM command was sent again (18:08:38 GMT).
- First data was received at 18:09:43 GMT.
- During the first MSB break, the PIES spontaneously stopped sending data. At 18:32 GMT another TELEM command was sent, followed by several CLEAR commands and several more TELEM commands. We tried a TELEM command again and set the gain in the Matlab program to 1 at 18:42 GMT. Strangely the data began coming in at year days not far from where it had broken off nearly a half-hour earlier. The data received was quite noisy, and at 18:56 GMT we switched to the "Obi-Wan-Kenobi" Benthos DS-7000 unit with the gain set to 2. Immediately we began receiving good data. The first MSB were collected with the "Obi-Wan" deck unit.
- Final data was received at 20:05 GMT, reaching the start of the record.

- The ship drifted a total distance of 0.05 nm during the download.
- The Site A instrument was visited a second time due to the noisy data quality in the first download prior to changing to the "Obi-Wan" deck unit. We arrived at the site at 01:21 GMT on April 30, 2009.
- CLEAR command was sent and acknowledged at 01:22 GMT
- TELEM command was sent at 01:23:50 GMT
- First data was received at 01:26 GMT, however it appeared to be noise, not good data
- Second TELEM command was sent at 01:31:00 GMT
- "First" data received at 01:31:30, however the first record was missed, which may indicate the first TELEM command was actually successful.
- Data was collected back to 2008 yearday 315, which was deemed sufficient by the chief scientist because of the quality of data collected earlier in the first telemetry session at site A.
- Distance drifted cannot be determined as starting latitude and longitude were not noted on the log sheet, however given the station-keeping abilities of the ship it is likely this drift was less than 0.1 nm.

Site B: (PIES SN#220)

- Arrived on site April 19, 2009 at ~12:00 GMT. CTD station #6 was commenced at the site prior to the start of telemetry.
- Communication was done with the "Obi-Wan-Kenobi" Benthos DS-7000 unit.
- Clear command was sent at 12:20 GMT, however no two ping response was received. Several more CLEAR commands were sent, with no reliable reply.
- TELEM command sent at 12:32 GMT with no response.
- For about an hour we tried numerous different commands and we even tried the "R2-D2" deck unit again despite it's earlier problems. At no time did we receive any signals or replies, nor did we hear the PIES sample on the hour.
- At the end of the CTD cast we gave up planning to revisit the site during the mooring week.
- We returned to Site B on April 27, 2009 at about 23:45 GMT. We put over both the "Obi-Wan" transducer and the ORE transducer for the deck unit that Bill Johns had sent with us. We also watched the new Bathy2010 display on the ship in "passive" mode. We did not hear any sign of an hourly sample by the PIES. We tested several CLEAR commands with no reply after the sampling period was over.
- Finally we decided to try for a release in the hope that the instrument might have a damaged transducer and may be able to

hear us but not reply. The release command was first sent at April 28, 2009 00:17:35 GMT, and was sent 10-15 times during the next 20-25 minutes. We then moved the ship about 250 m northward to wait for the possible recovery.

- We waited for ~50% longer than it should have taken the instrument to rise (2 hours rather than 80 minutes) with no sign of the instrument. We tried contacting the PIES again from this second site using both deck units and both transducers with no reply. Decided the instrument is either dead or deaf (or possibly 'asleep' due to passivization).
- Decided to deploy the backup model 6.1c IES (SN#22). Deliberately set the IES clock 15 minutes early so that if the SN#220 PIES begins sampling again the two will not talk to one another.
- The IES (SN#22) had been started at 00:44 GMT.
- The IES was deployed at 02:57 GMT April 28, 2009.
- The IES was observed sinking at 03:45 GMT by watching the receipt of the travel time samples on the Bathy2010 display. The pings were not particularly strong on the display, but they were fairly clear.
- The IES was NOT observed sampling on the Bathy2010 display in the following hour (04:45 GMT) when it should have been on the bottom. We've had problems hearing the 6.1c models before, so for now we're hoping the instrument was simply transmitting too weakly to be heard from the total depth of 4811 m (it should have been at about 3000 m when it was observed sinking).
- This older model IES is not capable of telemetry. The plan will be to try and purchase a replacement model 6.2 PIES instrument in time for deployment in fall 2009.

Site C: (PIES SN#134)

- Arrived on site April 20, 2009 at 04:06:36 GMT. CTD station #9 was commenced at the site prior to the start of telemetry.
- Data was downloaded with the "Obi-Wan-Kenobi" Benthos DS-7000 unit.
- CLEAR command sent at 04:19 GMT and two ping response received.
- Telemetry command sent at 04:21:00 GMT, no response received. A second TELEM command was sent at 04:29:15 GMT and a response was received.
- First data record was received at 04:32:00 GMT.
- No final clear command was sent because the entire data record had been recovered (back to yearday ' 375')
- Final data was received at 06:19:00 GMT.
- The ship drifted a total distance of 0.09 nm.

Site D: (C-PIES SN#133)

- Arrived on site April 20, 2009 at 14:30 GMT. CTD station #11 was commenced at the site prior to the start of telemetry.
- Data was downloaded with the “Obi-Wan-Kenobi” Benthos DS-7000 unit.
- CLEAR command sent at 14:42 GMT and two ping response received.
- Telemetry command sent at 14:44 GMT. After ~10 minutes of receiving no data, the transducer was lowered another ~2 feet and we immediately began receiving data. Although 10 minutes had elapsed since the TELEM command had been sent, the first data received was the first data that should have been sent. Not sure why it took so long for the CPIES to begin transmitting data.
- First data record was received at 14:56 GMT.
- A clear command was sent at 18:19 GMT to stop download as sufficient data (back to 2008 yearday 124) had been received.
- Final data was received at 18:19 GMT.
- The ship drifted a total distance of 0.03 nm.
- The CPDTb.m Matlab telemetry program crashed four times during the download.

Site E: (PIES SN#140)

- Arrived on site April 23, 2009 at 11:10 GMT. CTD station#23 was commenced at the site prior to the start of telemetry.
- Data was downloaded with the “Obi-Wan-Kenobi” Benthos DS-7000 unit.
- CLEAR command sent at 11:49 GMT and two ping response received.
- Telemetry commands were sent at 11:42, 11:53, and 11:59 GMT. No data was received and no two ping reply was observed. The PIES began sampling on the hour, and then at the end of the sample period the instrument began to telemeter data *WITHOUT* us sending an additional TELEM command. The hourly sample was very clear (alternating 16 and 18 second 12kHz pings), and no additional commands were sent prior to the start of the instrument telemetering data. Very strange.
- First data record was received at 12:08:30 GMT.
- No clear command was sent at the end of the record because we downloaded back to the start of the record (yearday ‘374’).
- Final data was received at 13:40:50 GMT.
- The ship drifted a total distance of 0.02 nm during the download.

SADCP Report

Personnel: Christopher Meinen

The shipboard ADCP (SADCP) on the Ronald H. Brown is a hull-mounted 75kHz "Ocean Surveyor" ADCP made by Teledyne - RD Instruments. It is capable of measuring velocity profiles down to 800-820m in good weather in its deep-profiling, lower resolution mode (narrow band), whereas in bad weather or low scattering conditions the range will be less. The present SADCP transducer was installed in late summer 2007. At the same time as the transducer was installed, a new Data Acquisition and preliminary processing System (UHDAS) was also installed to replace the VmDAS system that had formerly been on the ship. The SADCP-UHDAS on the Brown was installed by Dr. Julia ("Jules") Hummon over three days on September 5-7, 2007, and Drs. Jules Hummon and Eric Firing at the University of Hawaii have been monitoring it from time-to-time from shore. The computer system that the UHDAS system runs on is a Linux system called "Currents" that was purchased by Dr. Greg Johnson at NOAA/PMEL. What follows is a roughly chronological listing of all issues that were observed on the system during the 2009 WBTS cruise.

On April 13th the Chief Science Technician (CST) Jonathan Shannahoff turned on the SADCP system while the ship was still at the pier as a test at the request of the chief scientist. Dr. Hummon was informed that the SADCP was on and on April 14th she confirmed that she was able to log in remotely and that she thought the system was set up properly except for one unspecified software 'bug' that she would deal with at a later date.

On April 16th at 07:17am local time the SADCP system was started by the CST as the ship was sailing out from the port. The data files were stored in a directory called RB0901. On April 17th it was noted that the display on the SADCP computer would 'go to sleep' after just a few minutes and that it was necessary to bump the mouse every so often to get the screen to reactivate. Dr. Hummon was informed, and she indicated that it was a known bug that would have to be fixed the next time the system was updated.

At approximately 7am local time on April 25th, the chief scientist noticed that while the display panels on the SADCP monitor were all green and the data fields within the green blocks were all refreshing regularly and appeared to have reasonable values, the figures on the UHDAS intranet web page were not refreshing. In fact nearly all of the panels on the frame page indicated that they had not been updated since about 23:45

GMT the night before. Only the narrow-band and broad-band vector plots were updating. Dr. Hummon was notified via email, and she indicated that there was a problem with a 'nonmonotonic timestamp' in the file that had hung the plotting routines. Conveniently the problem had occurred just after the end of the long 'Abaco' CTD section and during the beginning of the mooring work. To fix the problem Dr. Hummon suggest the shutdown and restarting of the SADCP system. This was done in the afternoon on April 25th, and the resulting files were located in a directory called RB0901a.

On April 27th a new bug appeared in the SADCP processing software. The narrow-band data plots began indicating that some of the data that had been collected had been observed in South Central Texas rather than out on the ocean where we were sailing. Dr. Hummon indicated that this was resulting from another known bug that sometimes wrote the digital day into the longitude field in the UHDAS software. Dr. Hummon indicated that the data set would need to be reprocessed "from scratch" at the end of the cruise due both to this new problem and due to the earlier timestamp problem.

Also on April 27th, Dr. Hummon emailed the chief scientist to inquire about the possibility of finding an additional computer to serve as a backup for the SADCP system on the Brown or as a new primary computer with the existing system becoming a backup. The chief scientist discussed this with the Brown Chief Electronics Technician (CET) Jeff Hill. The CET offered to retask an existing computer into this role, and after several emails back and forth between the chief scientist and Dr. Hummon it was agreed that the CET would buy a new hard drive and a few additional components for the existing system and then he would send it to Dr. Hummon in Hawaii where she would install the newest version of the UHDAS software and then ship the computer back to the CET for installation on the Brown.

LADCP Report

Personnel: Kyle Seaton, Ben Shaw, and Carlos Fonseca

Data Acquisition Set-Up: The LADCP PC was set up in the aft wet lab. Relatively new deck leads from previous cruises were utilized. Two different ADCP setups were used on the package during the cruise, each requiring slightly different deck lead configurations. One configuration was a hybrid LADCP system with a down looking BB150 and an upward looking WH300 (used on casts 000-028). The other LADCP system was a dual WH300 configuration (used on casts 036-060). Each will be discussed in more detail in the next section. In both cases three deck leads were run through a bulkhead conduit to the deck: one power cable with two stripped wires at one end and a two pin sea connector at the other and two communications cables with an RS232 connector at one end and the appropriate LADCP connector at the other end.

In the case of the hybrid system, the appropriate LADCP connectors were an eight-pin sea connector and a square seven-pin sea connector. With the dual workhorse configuration both LADCP sea connectors were square seven-pin connectors. The power cable was hooked up to the 64 V power supply in the lab. For the hybrid configuration the eight-pin communications cable was connected into COM1 of the PC, so that communication to the BB150 was via COM1, and the seven-pin communications cable was connected to COM6, so that communication with the WH300 was via COM6. For the dual workhorse configuration the master WH300 was hooked up to COM1 and the slave WH300 was hooked up to COM6.

Instrument Configuration: LADCP operations along the Abaco line were run with the “hybrid” LADCP system, with a down-looking BB150 and an up-looking WH300. This configuration was used along the Abaco line due to the BB150’s superior performance in the relatively low scatter environment presented along the line. The BB150 was configured with an 8m blank, 16m×16m bins, and a staggered ping cycle to minimize bottom interference layer problems (see command file ABACO_150.cmd in LADCP directory for all set-up details). The WH300 was configured with 16m×10m bins, a 1-second ensemble, and zero blank-after-transmit, which has been shown to reduce bias problems in the close bins (see ABACO_WHM.cmd). The first bin, which is contaminated by ringing, is then discarded during processing.

LADCP operations along the Florida straits lines were run with the dual WH300 LADCP system, with both a down-looking and up-looking WH300. Each workhorse was configured 6m×10m bins, a 1-second ensemble, and zero blank-after-transmit, which has been shown to reduce bias problems in the close bins (see AB0904_WHM.cmd and AB0904_WHS.cmd). The WH300s were also configured to alternate sampling windows, to prevent interference between the two units.

Pre-cruise Tests: A test cast was preformed on our transit to the Abaco line. We used this cast to test the hybrid LADCP setup and our data acquisition system.

Deployment and Recovery: Deployment and recovery were achieved by using BBTALK (Windows) to communicate with the instruments and send command files etc, except downloading of the BB150, which was achieved using a DOS RDI program BBSC.exe (see shortcut called RecoverBB150). Instrument voltages were checked before power supply was reconnected, using commands PT2 for the BB150 and PT4 for the WH300s.

Processing: First-pass processing was skipped for this trip, due to bug associated with the processing software. The processing software was not able to produce useful plots without incorporating CTD data from the casts. So, what is referred to as second pass processing became the first pass for this cruise. This processing was run on a processing laptop computer using 10-second nav data (RHBnav.m) that was pulled from the ship's network and version X_MV of the Visbeck LADCP software, made available by Gerd Krahmann.

The second pass processing involved using time series CTD data (standard SeaBird output: _WE-CTM-Filt.cnv), bottom-tracking velocities, and navigation data to constrain the LADCP full-depth ocean velocity profile. Second-passed LADCP profiles are available as of cruise. The remaining processing step, to utilize SADCP velocities in the inversion, will be completed after the cruise when the final SADCP data is available.

Problems/Issues: Operations ran quite smoothly during this cruise after some initial issues associated with a new battery pack configuration were ironed out. The new battery pack supplied the ADCPs with a higher input voltage, but the power supply used to charge them was not adjusted to reflect this change. Charging at a lower than optimal voltage resulted in the battery pack running out of charge between stations. Initially we switched to our back up battery pack, thinking the issue was related to the battery pack composition, but the same issue occurred with the back up. When the charging voltage was raised the issue subsided (charging times also increased at roughly the same time due to longer station transit distances). This issue affected stations 5, 7, 11 and 12. Station 12 was the only cast where the data collected could not be processed into a reasonable velocity profile using the Visbeck software.

We also had a minor equipment failure issue on stations 13 through 17. The up looking WH300 failed to collect data for a portion of each cast. The issue was not noticed until after station 17, when the malfunctioning WH300 was replaced with a back up. It appears that the malfunctioning WH300 (serial number 1410) has a pressure cycling problem causing it to stop functioning properly below depths of approximately 2000 meters. The Visbeck processing software was still able to produce quite reasonable profiles of velocity from these casts due to the fact that the WH300 generally do not produce much useful data below 2000 dbar in this region anyway due to the low level of scatterers. The fact that this WH300 functioned properly above this depth allowed us to utilize it for the Florida Straits portion of the cruise where it was once again utilized as the up looking LADCP.

On several casts near the east end of the Abaco line it was necessary for time-reasons to test several IXSEA acoustic releases for the UK moorings during the CTD casts. This was done by removing two Niskin bottles on opposite sides of the frame and strapping the releases into their places – the package was then stopped about 100 m above the bottom during the up-cast and the acoustic releases were tested using over-the-side transducers. It was discovered once the first few releases were tested that while the acoustic releases were active they strongly interfered with the compass in the BB150 LADCP, causing it to swing wildly. It is likely that the source of this interference was the magnetic solenoid in the release mechanism. On the first cast the effect was noted for about 20 minutes, and during the second it was noted for nearly an hour because the UK group was having difficulty with one of the releases they were testing. It was necessary for time reasons to do a few more casts with releases for testing to avoid losing an entire sea-day later in the cruise, however the release tests were thereafter limited to less than 20 minutes on any given cast and in practice communication was completed within 10 minutes, although it appears the compass may take an additional 10-15 minutes to recover once the releases are disabled (shut-down). Given the fact that the package was not moving during the time period of the testing, and the fact that the velocities at the depth where the testing occurred (typically around 4700 dbar) are very low (typically < 5 cm/s), it is not expected that this interference will cause a large error to the final processed velocity profiles, however this will need to be investigated further during post-processing after the cruise.

The Visbeck processing software produced multiple error messages when processing the hybrid LADCP data. An error message related to the sampling rates of the two instruments and the battery voltage of the instruments was seen persistently when processing the hybrid data. Intermittent error messages suggesting that the accuracy of the data from the instruments may not be of the highest quality due to the operating conditions (low scatter) along the Abaco line also appeared. The processing software threw very few errors when processing the data from the dual WH300s configuration used along the Florida straits lines.

Significant Event Log:

4/15/09
The ship delayed sailing due to a generator failure. Repairs were made and the ship departed one day late on the 16th. The LADCPs were mounted on the frame before shipping them to Charleston. The deck leads and processing computer were set up on the 15th with involvement from the entire AOML science party.

4/19/09
Battery voltage issues start to appear, with the voltage reported by the BB150 falling bellow the optimal level and multiple data sets being recovered from the instruments.

4/20/09
The battery voltage issues are resolved. After switching between fully charged battery packs a couple of times the power supply voltage is adjusted to more aggressively charge the battery packs. The higher charging voltage along with longer transit times resolves the issue.

4/25/09
The BB150 is removed from the frame and replaced with a WH300. This swap was done to protect the BB150 from damage, because of it status as irreplaceable. The need for the BB150 is limited in the Florida Straits in any regard, as the high scatter environment in that shallower region allows the WH300s to function very well.

Special Note:
To avoid blown fuses on the WH300, when the CTD package comes up on deck:

1- Remove the 7 pin connector from the WH300 (MUST do this first)
2- Disconnect 4 pin connector from battery pack on CTD package—connect directly to charger and charge battery
3- Connect the fully charged spare battery pack to the 4 pin connector and download using power from spare battery
4- Then after data download, disconnect WH300 7 pin connector.
5- Swap batteries.
6- Make WH300 connection after all power connections are done.

LADCP Command files:

ABACO_150.cmd (Used on casts 000-028):

```
$D2
$L
$P                                      .
$P       ABACO - SEPTEMBER 2006    (RVSJ)       .
$P                                      .
$P       BB150kHz LADCP DEPLOYMENT SCRIPT       .
$P                                      .
$D3
$B
$D2
; Check the recorder
CY
; Pause 2 seconds
$D2
; Factory defaults
CR1
; Echo Firmware etc
$D1
$P                                      .
$P  Instrument S/N:  1133                       .
$P                                      .
PS0
$D2
; Our commands
CT0
EZ0011101
EC1500
EX11101
WD111 100 000
WL0,4
WP1
; Sixteen bins of 16 m length
WN016
WS1600
WF1600
; Pause 3 s
$D3
WM1
WB1
; Ambiguity velocity 3.5 m/s
WV350
WE0150
```

```
WC056
CP255
CL0
BP0
; Ping in 2.2 s bursts
TP00:00:00
TB00:00:02:20
TC2
TE00:00:00:80
CF11101
; Pause 2 seconds
$D2
; Save
CK
; Pause
$D1
; echo config to logfile
B?
C?
D?
P?
R?
T?
W?
$D8
$P                                  .
$P                                  .
$P      NOW RUNNING WITH CHEESY POOF...              .
$P      GO CHEESY GO!!!                     .
$P                                  .
$P                                  .
$D1
; Start Pinging
CS
; End of log file
$D2
$L
```

ABACO_WHM.cmd (Used on casts 000-028):

```
; ASK FOR LOG FILE
$L
$P                                    .
$P        ABACO - SEPTEMBER 2006    (RVSJ)        .
$P                                    .
$P        WH300kHz LADCP DEPLOYMENT SCRIPT        .
$P                                    .
$D3
PS0
$D2
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0111111
$D2
TE00:00:01.00
TP00:01.00
LD111100000
; Pause
$D2
; setting the blank-after-transmit to zero
; following an idea of Andreas Thurnherr
LF0000
LN016
LP00001
LS1000
$D1
LV250
LJ1
LW1
LZ30,220
SM1
SA001
$D2
SW05000
CK
$D2
; echo set-up
T?
L?
```

```
; Pause
$D5
; start Pinging
CS
; End Logfile
$L
```

AB0904_WHM (Used on casts 036-060):

```
; ASK FOR LOG FILE
$L
$P                                          .
$P           WBTS -- APRIL/MAY 2009 (Ron Brown)          .
$P                                          .
$P        WH MASTER 300kHz LADCP DEPLOYMENT SCRIPT       .
$P                                          .
$D3
PS0
$D2
CR1
CF11101
EA00000
EB00000
ED00000
ES35
EX11111
EZ0111111
$D2
TE00:00:01.00
TP00:01.00
LD111100000
; Pause
$D2
; setting the blank-after-transmit to zero
; following an idea of Andreas Thurnherr
LF0000
LN016
LP00001
LS1000
$D1
LV250
LJ1
LW1
LZ30,220
SM1
SA001
$D2
SW05000
CK
; echo set-up
;$E?
;$P?
;$R?
```

```
;$T?
;$L?
; Pause
$D4
T?
CS
$L
```

AB0904_WHS (Used on casts 036-060):

```
; ASK FOR LOG FILE
$L
$P                                        .
$P          WBTS -- APRIL/MAY 2009 (Ron Brown)        .
$P                                        .
$P        WH SLAVE 300kHz LADCP DEPLOYMENT SCRIPT       .
$P                                        .
$D3
PS0
$D2
CR1
CF11101
EA00000
EB00000
ED00000
ES35
; Pause
$D2
EX11111
EZ0111111
TE00:00:01.00
TP00:01.00
; Pause
$D2
LD111100000
$D1
; setting blank-after transmit to zero
; following conversation with Andreas Thurnherr
LF0000
LN016
LP00001
LS1000
LV250
LJ1
LW1
LZ30,220
SM2
SA001
ST0
CK
;Pause
$D2
; Echo config to logfile
T?
```

L?
$D5
; Start Pinging
CS
; End Logfile
$L

Summary of UK Rapid-MOC mooring operations

Personnel: Darren Rayner, Harry Bryden, Rob McLachlan, Paul Wright, Christian Crowe, Colin Hutton, David Childs, Stephen Whittle, Emma Heslop

In total six moorings and two landers were recovered, and seven moorings and two landers were deployed for the UK Rapid-MOC project. Positions of the mooring recoveries and deployments are given in the two tables below. Recovery of a third lander was attempted for Bill Johns from RSMAS, Miami but this was lost when attempting to hook into it from the ship.

Instrumentation recovered from the moorings consisted of 52 SeaBird SBE37 MicroCAT CTDs, four SeaBird SBE26 Bottom Pressure Recorders (BPRs), 23 Aanderaa RCM11 current meters and one RDI 75kHz Longranger ADCP. Of these instruments three MicroCATs were flooded so yielded no data. The replacement moorings consist of 54 SeaBird SBE37 CTDs, four Seabird SBE53 BPRs, fourteen Aanderaa RCM11 current meters, nine Nortek Aquadopp current meters and one RDI 75kHz Longranger ADCP.

In addition to the established mooring sites, an extra mooring was deployed to compare different makes of current meter. This mooring had one each of a Nortek Aquadopp, an InterOcean S4, an Aanderaa RCM11, a Sontek Argonaut MD, a TRDI Doppler Volume Sampler and a TRDI 300kHz Workhorse Sentinel ADCP.

The current meter comparison mooring will be recovered in Autumn 2009, with the main moorings recovered in Spring 2010, except the landers (WBL1 and WBL2) which will be deployed for 2 years with recovery in 2011.

Mooring operations were conducted from the stern with a double barrel winch and dual reeler system used in conjunction with a floating block raised and lowered from the A-frame through use of the ship's air-tuggers. The ship's cranes were used for anchor deployments.

Prior to deployment cross calibrations of the MicroCAT CTDs were completed by lowering the instruments on the shipboard CTD frame with five-minute bottle stops to allow the slower responding MicroCAT sensors time to stabilize relative to the shipboard CTD. Eight casts (stations 11, 12, 15-17, 19-20, and 23) with up to six instruments were combined with the long WBTS section east of Abaco Island, and a further six casts (stations 30-35) with up to twelve instruments completed during the nights of the mooring operations. Acoustic releases were also lowered on the frame and tested at depth prior to their use on moorings.

Table 4 – List of Moorings recovered during cruise

Mooring	NMFD-ID	Deployment Cruise	Latitude N	Longitude W	Date	Time of release (GMT)
WB6	2007/07	RB0701	26°30.02	70°31.21	25/4/09	10:48
WB4	2008/04	SJ0408	26°25.16	75°42.29	27/4/09	10:45
WBL2	2007/06	RB0701	26°31.04	76°08.86	27/4/09	17:08
WBH2	2008/08	SJ0408	26°27.90	76°39.03	28/4/09	17:15
WB2	2008/03	SJ0408	26°30.12	76°44.52	29/4/09	10:42
WBL1	2007/05	RB0701	26°30.38	76°44.68	29/4/09	15:24
WB1	2008/02	SJ0408	26°30.00	76°49.23	30/4/09	10:31
WBADCP	2008/05	SJ0408	26°31.52	76°52.12	18/4/09	14:02
E-lander	n/a	n/a	26°30.52	71°58.38	25/4/09	20:36

Moorings recovered on cruise RB0901. NB – E-Lander lost when attempting grapnelling

Table 5 – List of Moorings deployed during cruise

Mooring	Anchor Position		Water depth (m)	Date	Time (GMT)
	Latitude N	Longitude W			
WBADCP	26° 31.54'	76° 52.08'	593	18/4/09	13:52
WB6	26° 29.691'	70° 31.313'	5488	25/4/09	13:54
WB4	26° 21.180'	75° 43.320'	4713	26/4/09	21:04
WBL2	26° 21.261'	75° 42.949'	4713	26/4/09	22:39
WBCM	26° 30.0'	76° 35.986'	4825	28/4/09	13:16
WBH2	26° 29.076'	75° 37.980'	4736	28/4/09	16:24
WB2	26° 30.805'	76° 44.425'	3884	29/4/09	22:04
WBL1	26° 30.378'	76° 44.629'	3882	29/4/09	14:27
WB1	26° 30.132'	76° 49.038'	1390	30/4/09	19:03